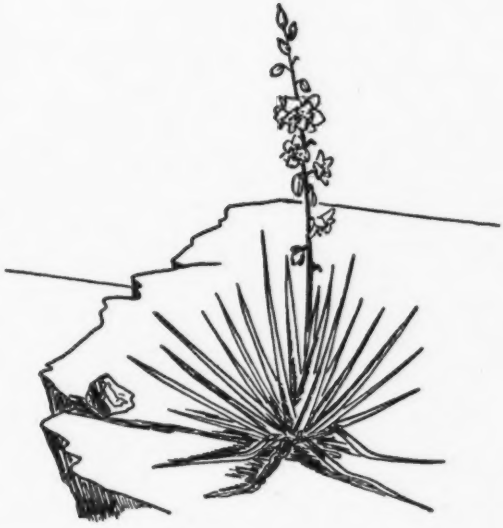
THE SOUTHWESTERN NATURALIST



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PHORADENDRON SEROTINUM FOR P. FLAVESCENS (LORANTHACEAE): NOMENCLATURAL CORRECTIONS

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ABSTRACT. Pursh (1814) referred the mistletoes of the southeastern U.S. to the West Indian *Viscum flavens* Sw., misspelling the name *flavescens*. The latter epithet has been widely used in the combination *Phoradendron flavescens*, applied to a different species from the West Indian one, but as a mere misspelling not intended as the name of a new species, it has no nomenclatural standing. To replace the illegitimate *Phoradendron flavescens*, the new combination *P. serotinum* (Raf.) is published, and transfers are made for 4 varieties: var. *pubescens* (Engelm. ex Gray), var. *macrophyllum* (Engelm.), var. *rotundifolium* (Trel.), and var. *macrotomum* (Trel.).

Pursh (1814: 114) referred the mistletoes of the southeastern United States doubtfully to *Viscum flavens* Swartz (1788) of the West Indies, misspelling the name as *flavescens*. He added that he doubted "whether this is truly *V. flavescens*." Subsequent authors (except Elliott and Rafinesque) adopted the epithet *flavescens* for our plants, clearly differentiating them from the Old World and West Indian mistletoes. Nuttall (1848: 185), when he segregated *Phoradendron* from *Viscum*, indicated that to the new genus he "would refer the . . . *Viscum flavescens*." A formal transfer was made seven months later (Gray, 1849: 59). Trelease (1916: 33), the monographer of the genus, was aware of the "curious fact" of Pursh's error, through which "the mistletoe of the southeastern United States . . . obtained its now long-established specific name." After an additional two score years of entrenchment, *flavescens* still has no legitimacy. Our mistletoe must be known by a new name:

PHORADENDRON **serotinum** (Raf.) M. C. Johnston, new comb., based on *Viscum serotinum* Raf. Ann. Gén. Sci. Phys. 5: 348, 1820 (*fide* Merrill); New Fl. N.A. 3: 22–23, 1838 ("1836"). "*Viscum flavens* Sw., [Prodr. Fl. Ind. Occ. p. 32, 1788]" (sphalm. "*flavescens*") sensu Pursh, Fl. Am. Sept. 1: 114. 1814. *Phoradendron* "*flavescens* (Pursh)" Nutt. ex Engelm. in Gray, Pl. Fendl. (Mem. Amer. Acad. n.s. 4 pt. 1): 59. 1849. *(Nomen illegitimum.) Viscum leucarpum* Raf., Fl. Ludov. p. 79. 1817. (Not *Phoradendron leucocarpum* Patschofsky, Bot. Jahrb. 45: 438–439, 1911. Though Rafinesque's epithet differs by

two letters, it is a variant spelling of the same word, and so similar to Patschofsky's as to be likely to cause confusion. In accordance with Article 75 of the International Code of Botanical Nomenclature, Rafinesque's name, though the earliest legitimate one, is not adopted.)

Although Rafinesque's name cannot be tied to any authentic specimens, its identity is clear enough (cf. Trelease, 1916: 30, and Merrill, 1949: 114). For the taxonomy, I follow in large part the very condensed treatment of the series *Flavescentes* by Fosberg (1941: 277–280). Sixteen of Trelease's species are there merged into five varieties under *Phoradendron flavescens;* the seventeenth, *P. Coryae* Trel., is not reduced. Following is an enumeration of varietal names under *P. serotinum.* Additional combinations for Mexican taxa will probably be needed. For further synonymy, see the treatment of Fosberg.

1. P. SEROTINUM var. SEROTINUM. *P. "flavescens"* auct. mult. These are the glabrous plants of southeastern United States, ranging as far west as eastern Texas, eastern Oklahoma, southeastern Kansas, and Missouri, and as far north as New Jersey, West Virginia, and southern Illinois.

2. P. SEROTINUM var. **pubescens** (Engelm. ex Gray) M. C. Johnston, new comb., based on *P. flavescens* var. *pubescens* Engelm. ex Gray, Pl. Lindh. 2 (Boston Journ. Nat. Hist. 6): 212, 1850. "On Muskit trees, Upper Guadaloupe, Elm, &c.," Comal Co., Texas, *Lindheimer exs. 406,* in 1846 (isotypes GH, US). These are the plants with stellate-tomentose to shortly hirtellous pubescence, the hairs usually branched or tufted (appearing "frosty" in the phrase of Fosberg), ranging from Veracruz, San Luis Potosi, and Chihuahua north to north-central Texas and southern New Mexico; also, by the synonymy of Fosberg, in western Jalisco.

3. P. SEROTINUM var. **macrophyllum** (Engelm. in Rothrock in Wheeler) M. C. Johnston, new comb., based on *P. flavescens* var. *macrophyllum* Engelm. in Rothrock in Wheeler, Rept. U.S. Geogr. Surv. W. 100th Meridian VI. Botany p. 252. 1879. "On Ash, Willow, Poplar, Sycamore, and Sapindus on the Gila and Bonita Rivers, and extending into Southern California," *G. K. Gilbert 104* and *Rothrock 362* (MO?). These are the blabrous or subglabrous mistletoes of southern California, Arizona, New Mexico, extreme western Texas, and northern Chihuahua, differing from var. *serotinum* in their heavier, longer staminate spikes (up to 5 cm. at maturity).

4. P. SEROTINUM var. **rotundifolium** (Trel.) M. C. Johnston, new comb., based on *P. villosum* var. *rotundifolium* Trel., Genus Phoradendron p. 42. 1916. Santa Barbara, California, "*Elmer, 3794* in part" (not examined). *Viscum villosum* Nutt. ex T. & G., Fl. N.A.

1: 654. 1840. "On trees in woods of the Wahlamet, Oregon, . . . *Nuttall*" in 1834 (not examined). These are the velutinous plants (with simple hairs) of the Pacific States from Oregon to Baja California. With these, Fosberg includes the velutinous plants with simple, non-tufted hairs, found in the mountains of San Luis Potosi, Hidalgo, and Zacatecas. These Central Mexican plants have been treated as *P. tomentosum* (DC.) Oliver, based on *Berlandier 1364* (isotype, GH), from leguminous plants on the Real de Catorce ("Catone" of Trelease), northwest of Matehuala in northern San Luis Potosi. *Phoradendron flavum* I. M. Johnston, Journ. Arn. Arb. 24: 93, 1943, is based on a specimen having both simple and stellate yellow hairs, *E. Palmer 777* (GH, isotype US), from Durango; this, Fosberg states, "must be regarded as intermediate" between var. *pubescens* and var. *villosum*.

5. P. SEROTINUM var. **macrotomum** (Trel.) M. C. Johnston, new comb., based on *P. macrotomum* Trel., Genus Phoradendron p. 34. 1916. Jacksonville, Florida, *Curtiss 4569* in 1894 (not examined). This is a glabrous Floridian race in which the staminate spikes are regularly elongate, up to 6 or 7 cm. at maturity.

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THE SOUTHWESTERN NATURALIST 2 (2–3): 48–73 APRIL–JULY, 1957

SALT CEDARS (TAMARIX, TAMARICACEAE) OF THE SOVIET UNION

BY S. G. GORSCHKOVA

Translation and commentary by

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ABSTRACT. An English translation is given of the whole account of *Tamarix* in the Flora of the Soviet Union, vol. XV, 1949, treating 20 accepted species, 5 hybrid species, and 3 species of doubtful status. In an Appendix are given a key to and notes on 7 taxons found in the Southwestern U.S., 5 of them wild. Except for *T. aphylla* (L.) Karst. (wild in Texas and Arizona, widely cultivated in warmer areas) and *T. africana* Poir. (rare, only in cultivation), the nomenclature of the introduced plants is either unknown or uncertain. *T. gallica* L. var. *gallica*, to which most U.S. plants are often referred, apparently is not found here. *T. pentandra* Pall., another name often applied to our plants, is not recognized in the FL. USSR, though described from Russia. Most of our naturalized plants are in the *T. gallica* complex and may eventually prove to be named varieties of that species. A few collections from the Texas Gulf Coast are tentatively referred to *T. speciosa* Ball of North Africa, not previously reported from the New World; distinguished by producing few simple racemes on old wood in summer, and by the lowest floral bracts having tips differing in texture and color from the body.

Tamarix is familiar in cultivation in the United States, except in colder areas. In the Southwest it is not only planted, but widely naturalized in stream bottoms and on the Gulf Coast. It is apt to become a pest, and is known to cause heavy water loss from reservoirs (*cf.* Young & Blaney, 1942; Gatewood *et al.*, 1950). Many botanists (*e.g.*, Shinners, 1948) have carelessly referred all the naturalized plants to one species, usually *T. gallica* L., sometimes *T. pentandra* Pallas. Following a suggestion from Dr. Elizabeth McClintock that I look more carefully at our material, I made additional collections, reexamined herbarium specimens, and concluded that we had at least 7 different salt cedars, in addition to which Dr. McClintock reported an 8th as found in Texas in cultivation. Unfortunately it has proved impossible to identify most of our plants, and a reasonably final conclusion as to the correct name could be reached only for two. The only recent monographic study (Zohary, 1956) deals only with Israel, and omits most of our species. The most extensive recent account is that for the Soviet Union. Because the work is not generally available in this country, and since it is in any case in an unfamiliar language, it seems worth while to publish a translation. I am indebted to Dr. Elizabeth McClintock, of the California Academy of Sciences, for helpful comments (as well as

the suggestion which led to the preparation of this translation), to Miss Nell C. Horner, Librarian, Missouri Botanical Garden, for the loan of Vol. XV of the FL. URSS (a copy was acquired for the SMU Herbarium shortly afterward), and to Mr. Warren M. Pulich, University of Dallas, for bringing to my attention the two bulletins discussing water relations of *Tamarix*.

Miss Gorschkova's treatment is a fairly creditable one for so complex a group, but it is certainly not definitive. It is curious that so little attention was paid to representatives of the genus outside the Soviet Union (except for some cases of species extending into immediately adjacent areas like Iran or Mongolia). One can scarcely believe that the widespread *T. gallica* complex of the eastern Mediterranean should have no significant relations with the Soviet flora. Left unexplained is the rejection of the name *T. pentandra* Pallas, which appears only as a synonym "in part" of the later-described *T. ramosissima* Ledeb. (her species no. 17). Even if based on a mixture, the name must be retained for one component, but it is impossible to learn what the possibly correct entity might be from Gorschkova's account. As with Zohary's treatment for Israel, a number of our introduced kinds are apparently not included. It must be inferred that these are of Western Mediterranean or North African origin. Nevertheless, since the early accounts of the genus were prepared by or with extensive aid from Russian botanists, an extensive modern account prepared by a botanist who has not only had access to the classical collections, but has studied the plants in the field (*cf.* her remark under no. 6, *T. Litwinowii*) should be of great help with at least some of our problems.

In the translation which follows, original page numbers are given in brackets. The manufactured common names (straight Russian translations of the Latin binomials) are omitted, as is the botanical symbol for a woody plant which appears at the start of every description in the original. No attempt is made to be consistent in handling the bibliographic citations. In some cases a Russian author already has adopted a westernized form of his name (usually adopting German style, as Gorschkova rather than Gorshkova), in others not; some titles have more or less familiar equivalents, some do not. The general policy has been to use forms which exist, to translate those which lend themselves to such handling, and merely to transliterate into Latin letters the name or title as given when this seemed simplest. In habitat designations, the terms solonchak and solonets (referring to alkali soils with salt concentrations reaching the A or B horizon respectively) are not easily translatable. Though not widely known to biologists, they are used by soil scientists throughout the world, and are adopted here.

Localities are given according to a somewhat arbitrary system which is explained in vol. I of the Flora (1934), with maps. The Soviet Union is divided into floral regions, which in turn are subdivided into districts. The major regions are readily identifiable; no special attempt is made here to elucidate the subdivisions, which are given mostly in transliteration, but partly in translation (especially geographic designations of north, south, east, west). Roman numerals at the end of each description indicate months of flowering.

[290] GENUS 900. GREBENSHCHIK—TAMARIX[1] L.

L. Sp. pl. (1753) 270.—*Trichaurus* Arn. in R. Wight a. Walker Arnott, Prodr. Fl. Pen. Ind. or. I (1834) 40.

Flowers mostly small, 1.5–3 (rarely 5) mm. across, bisexual, arranged in simple or compound racemes or panicles; bracts ovate, lanceolate, linear, or subulate, obtuse or acute or with cartilaginous tip, often inrolled, erect or spreading or deflexed, shorter or longer than the pedicels; shorter, equalling, or exceeding the calyxes (together with the pedicels), or sometimes shorter, equalling, or longer than the petals (together with the pedicels); calyx coriaceous or [291] fleshy, deeply 4–5 parted, persistent, with ovate, ovate-oblong, ovate-lanceolate, triangular-ovate or ovate-rhombic, nearly suborbicular, acute or obtuse lobes; petals 4–5 (rarely more), ovate, obovate, oblong, oblong-oval or elliptic, rosy or lavender, rarely scarlet or red, commonly inequilateral, obtuse or apically somewhat emarginate, erect, connivent, or spreading when expanded, in fruit persistent or deciduous; stamens 4–5 [rarely 6–12(14)], with slender or basally enlarged filaments, free, attached at base to a sub-ovarian ferruginous disk; anthers mostly cordiform, acute or obtuse; pistil 1, with upper part oblong-elliptic, conical, or bottle-shaped, 3-sided, a 1-celled ovary and 3–4 mostly short styles (2½)3–6(7) times shorter than the ovary, obovate-capitate; capsule 3–5-seeded, pyramidal, with 3 valves, dehiscing to the base, 1-seeded, (2)3–5(6) times longer than the calyx; seeds small, 0.5–0.7 mm. long, narrowly obovoid, erect, more or less compressed, apically with a beard from concealed base of 1-celled, long, whitish hairs. Shrubs or small trees to 3–5(–8) m. tall with numerous branches; leaves 1–7 mm. long, scale-like, crowded, sessile, covered with salt-secreting glands.

To the genus *Tamarix* belong about 90 species, distributed mainly in deserts, semideserts, and steppe areas of Europe, Asia, and northeastern Africa, where it forms a characteristic, often dominant association of coastal landscapes. In the mountains, along streams and at the mouths of springs and springlets, tamarisks reach an altitude of 1200–2100 m. and sometimes 2800 m. The area of distribution of species of the genus includes a rather wide belt from 10° W. Long. to 145° E. Long., with the main portion between 50–20° N. Lat., in Asia to 55° N. Lat., in Africa to 12° S. Lat. Separated from the main area, tamarisk occurs in tropical Africa, on the coast of the Gulf of Guinea, in Upper and Lower Guinea, and in Great Namaland and Damaraland [?[2]] in southern Africa. With us, 25 species.

1. Flowers mostly small, calyx 0.5–1 (rarely 2) mm. long; petals 1.3–2.5 (rarely 3–4.5) mm. long; stamens 4–5 (rarely 6–8); leaves more or less semiamplexicaule, rarely amplexicaule (subgenus 1. *Eutamarix* Gorschk.) . .2.

[1] From the name of the River Tamaris (formerly River Tambra) in the Pyrenees.
[2] Conjectural translation of *Zemle Gerero*, a name entirely unfamiliar to me. (Translator's note.)

+ Flowers mostly large; calyx 1.5–2.5 mm. long, petals 2.5–4.5(5) mm. long; stamens 10–13(14); leaves mostly amplexicaule or sheathing, rarely semi-amplexicaule (subgenus 2. *Trichaurus* (Arn.) Gorschk.) ..... 24.

2. Flowers 4(5)-merous; racemes mostly on last year's branches, rarely terminal (Sec. 1. *Vernales* Bge.) ..... 3.

[292]

+ Flowers nearly always 5-merous (rarely 4-merous); racemes mostly on young twigs, terminal, rarely lateral (Sec. 2. *Aestivales* Bge.) ..... 13.

3. Flowers 4-merous, rarely 5-merous; stamens 4, rarely 6–8 ..... 4.

+ Flowers nearly always 5-merous; stamens 5 ..... 13.

4. Racemes 5–15(20) cm. long ..... 5.

+ Racemes 2–6 cm. long or contracted, 1–1.5 cm. long ..... 7.

5. Stamens 8(6), of which 4 with filaments widened at base, attached to the corners of the 4-angled disk, the other 4 with filaments not widened at base, attached between the angles of the disk; flowering racemes 4.5–9 cm. long; bracts broadly linear, 4.5–5.5 mm. long, nearly equalling the petals; bark yellowish brown ..... 1. *T. octandra* Bge.

+ Stamens 4 (rarely 6); disk 4(6)-angled, bearing filaments with widened bases .. 6.

6. Racemes mostly broad, 5–13(15) cm. long, 5–9 mm. thick; bracts broadly linear, with base more or less widened; pistil with 4 styles; bark brownish gray or gray ..... 2. *T. Meyeri* Boiss.

+ Racemes mostly longer, not broad, 6–15(20) cm. long, 4–7 mm. thick; bracts linear, narrow, with base not widened; pistil with 3 shortened styles; bark gray-brown or yellowish ..... 3. *T. elongata* Ldb.

7. Leaves amplexicaule, white-margined; racemes in flower densely covered with scales; bark gray-brown ..... 8. *T. Kotschyi* Bge.

+ Leaves more or less semiamplexicaule, not bordered; racemes in flower with sparse scales ..... 8.

8. Racemes contracted, 0.5–3 cm. long, mostly broad, 0.5–1.5 cm. thick; pedicels equalling or longer than the calyxes; bark reddish brown or grayish ..... 9. *T. laxa* Willd.

+ Racemes elongate, 2–7 cm. long, not broad, 0.2–0.7 cm. thick; pedicels equalling or shorter than the calyxes ..... 9.

9. Racemes 2–7 cm. long, 3–8 mm. thick; bracts triangular-lanceolate, acute, longer than the pedicels but mostly shorter than the calyxes; bark dark brown or black ..... 4. *T. tetrandra* Pall.

+ Racemes 1–5 cm. long, 2.5 mm. thick; bracts oblong or ovate-lanceolate, equalling or shorter, sometimes longer, than the pedicels; bark brown, reddish brown, or brownish red ..... 10.

10. Racemes solitary or mostly bunched; bracts equalling or shorter than the pedicels; woody shrubs or small trees ..... 11.

+ Racemes solitary, sessile or on short, 4-mm.-long peduncles; bracts mostly longer than the pedicels; shrubs with brown bark ..... 5. *T. araratica* (Bge.) Gorschk.

[293]

11. Racemes solitary or mostly bunched, without branchlets, 1–2(2.5) cm. long, 2–3(4) mm. broad; bracts ovate-lanceolate, acute ... 6. *T. Litwinowii* Gorschk.

+ Racemes mostly bunched, commonly with slender branchlets, 3–5 cm. long, 3–4 mm. broad; bracts oblong with spinose tip ..... 7. *T. Androssowii* Litw.

12. Racemes 2–5 cm. long, 2–3(4) mm. thick; bracts broadly ovate, acute, longer

than the pedicels, but not exceeding the calyxes; petals deciduous; disk 10-lobed (10-bladed); bark purplish-rusty.....11. *T. florida* Bge.

+ Racemes 3–9 cm. long, 3–5(8) mm. thick; bracts linear-oblong, obtuse, exceeding the calyxes; petals persistent; disk 5-lobed; bark brown-red .....10. *T. Hohenackeri* Bge.

13. Plant all densely coated with erect, short hairs; bark brown-red..... .....14. *T. hispida* Willd.

+ Plant bare, not coated .....14.

14. Racemes terminal, rarely lateral, not elongate, (0.5)1–4(6) cm. long, 3–5 mm. thick; flowers 4–5-merous; stamens 4–5.....15.

+ Racemes always terminal, mostly long, 6–10 cm. long or more elongate, 6–15 cm. long, very rarely contracted (1–3 cm. long); flowers always 5-merous, stamens 5 .....16.

15. Racemes 1–4(6) cm. long, 4–5 mm. thick; bracts lanceolate-subulate, petals deciduous; bark brownish-chestnut.....12. *T. gracilis* Willd.

+ Racemes 0.5–2 cm. long, 4 mm. thick; bracts ovate; petals more or less persistent; bark reddish purple.....13. *T. leptopetala* Bge.

16. Disk 5-angled, exceeding in width the bases of the staminal filaments, or disk 5-lobed, with slender staminal filaments (not widened at base) attached to the lobes of the disk.....17.

+ Disk 5-lobed, or 10-lobed or 10-angled, with slender staminal filaments attached between the lobes or angles of the disk.....20.

17. Racemes 0.7–3 cm. long or 4–10 cm. long; disk 5-lobed; staminal filaments slender, attached to the lobes of the disk.....18.

+ Racemes elongate, 6–15 cm. long; disk 5-angled, exceeding in width the bases of the staminal filaments.....19.

18. Racemes crowded, spike-like, short, 0.7–3 cm. long, in dense, compound panicles; bark reddish brown.....15. *T. Bungei* Boiss.

+ Racemes mostly sparse, longer, 4–10 cm. long, in more or less dense, non-compound panicles; bark brown or gray-brown...21. *T. karakhorum* Gorschk.

[294]

19. Racemes drooping, in spreading panicles; anthers acute; twigs drooping; bark dark purplish or violet-brown.....22. *T. Karelinii* Bge.

+ Racemes more or less appressed, in dense compound panicles; anthers obtuse; twigs appressed; bark reddish gray.....16. *T. leptostachys* Bge.

20. Racemes in simple, spreading panicles; petals persistent.....21.

+ Racemes in compound panicles; petals deciduous.....22.

21. Racemes crowded; bracts ovate, mostly exceeding pedicels and calyxes; petals erect, caducuous; anthers obtuse; bark magenta-purple or reddish brown, sometimes nearly yellowish.....17. *T. ramosissima* Bge.

+ Racemes more or less scattered [or sparse]; brachts linear, nearly subulate, mostly longer than the pedicels; petals spreading; anthers acute; bark reddish brown .....23. *T. Ewersmannii* Presl

22. Racemes elongate, 4–15 cm. long, 3–4 mm. thick; brachts lanceolate, acuminate, equalling or shorter than the pedicels; bark reddish borwn..... .....24. *T. Korolkovii* Rgl. et Schm.

+ Racemes not elongate, 2–6(9) cm. long; bracts ovate-subulate or lanceolate, equalling, shorter than, or exceeding the calyxes.....23.

23. Racemes 3–6(9) cm. long, 2.5–3 mm. thick; bracts ovate-subulate, exceeding the calyxes; bark reddish-purplish.....18. *T. arceuthoides* Bge.

+ Racemes 2–3 cm. long, 3–3.5 mm. thick; bracts lanceolate, acuminate,

equalling or shorter than the calyxes; bark brownish-ashy.....
.....19. *T. karakalensis* Freyn et Sint.

24. Racemes broad, 1 cm. thick; bracts ovate-deltoid or broadly cordate-deltoid, mostly shorter than the pedicels; flowers large, petals 3–4 mm. long; stamens 12–13(14), rarely 10; disk 12–13(14), rarely 10-lobed, exceeding the width of the base of the filaments; bark violet- or purple-brown or gray-brown .....20. *T. passerinoides* Delile

\+ Racemes not broad, 0.4–0.6 cm. thick; bracts lanceolate, more or less shorter than or equalling the calyxes (pedicels included); flowers less large, petals 2.3–2.5 mm. long; stamens 10; disk 5-lobed; filaments slender, with base not enlarged, attached to the lobes of the disk and between them; bark brown .....25. *T. Komarovii* Gorschk.

Economic Importance. Representatives of the genus *Tamarix* are fine ornamental plants, are valuable stock for planting especially on saline soils and for binding sands. Strong growth, ability to multiply by root-sprouts and cuttings (latter when moist and completely covered produce adventitious roots) make the [295] use of tamarisk very suitable for afforestation of alkaline steppes and sandy lands. All species of the genus are good honey plants. The wood is hard, dense, suitable for lathe work. All parts of the plant are rich in tanning material—in the bark 16–18%, in the leaves 11–12%. Ashes contain Na_2SO_4 in abundance. In popular medicine the leaves of tamarisk are used for ailing spleen, the flowers against jaundice, the bark as an astringent means against hemorrhage, and a decoction of the twigs for rheumatism (Rollov. Dikor. r. Kavk. [Wild Plants of the Caucasus], 496; Sukachev, Dendrol., 523).—Twigs of some species are used for coloring leather (O. A. Endev, in Tr. Turkm. Fil. Ak. Nauk SSSR vyp. V). Tamarisks, from some content of wax, are excellent fuel when green; also, when blazed, they are markers for desert travelers (N. V. Pavlov, Fl. Centr. Kazakhst., II. 474).

Subgenus 1. **EUTAMARIX** Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR [Acad. Sci. USSR], VII, 4 (1938) 78, 81.—Flowers not large, mostly small; calyx 0.5–1 (rarely 2.3) mm. long, petals 1–2.5 (rarely 3–4) mm. long; stamens 4–5 (very rarely 6–8), equal; leaves semiamplexicaule.

Sect. 1. **Vernales** Bge., Tentam. Gen. Tamar. spec. (1852) 17. Flowering racemes on branches of the previous year, lateral, rarely terminal, mostly early-blooming; flowers mostly 4-merous, rarely 5-merous.

Ser. 1. **Elongatae** Gorschk.—Flowering panicles mostly elongate, 9–20 cm. long, broad, 0.4–1 cm. thick; bracts broadly linear or linear, equalling or exceeding the perianth; stamens 4–8.

1. **T. octandra** Bge. Tentam. Gen. Tamar. spec. (1852) 17; Boiss. Fl. Or. I, 766; Reg. & Mlokoss. in Mat. Fl. Kavk. III, 9 (1909) 109); Medv. Der. & Kust. Kavk. 10; Grossh. Fl. Kavk. III, 77; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 81.—*T. rosea* Bge. Tentam. Gen. Tamar. spec. (1852) 19.—*T. tetragyna* var. *pallida* Trautv. in Tr. B. S. II (1873) 533.—*T. tetragyna* Radde, Die Samml. des Kaukas. Mus. II (1901) 68, non Ehrenb.—*T. octandra* var. *duplex* Rgl. et Mlokoss. et var. *rosea* (Bge.) Rgl. et Mlokoss. in Mat. Fl. Kavk. III, 9 (1909) 110.

Shrub with yellowish brown bark; leaves ovate-lanceolate or lanceolate, 1.5–2.7 mm. long, 1–3 mm. wide, acute, narrowly scarious-margined, sessile, with nearly cordate base, auricled. Racemes simple, lateral, more or less elongate and broad, 4.5–9 cm. long, 0.6–1 cm. thick, solitary or few, mostly spicate in contracted, 0.5–4 cm.-long inflorescences, covered with small scales; bracts broadly linear or oblong-lanceolate, 3.5–5.5 mm. long, 1–2 mm. broad, equalling or exceeding the perianth, acute, narrowly scarious-margined; pedicels 1 mm. [296] long; calyxes 2–3 mm.

long, nearly 1/3 shorter than the petals, with 4–5 (rarely 7) broadly ovate, nearly angulate lobes 1.5–2.5 mm. long, 1.7–2.5 mm. broad, acute, broadly scarious-margined; petals 4(5–7), rosy, obovate or oblong, more or less large, 3–4.5 mm. long, 1.2–1.5 mm. wide, deciduous; disk 4-angled; stamens 8, of which 4 with filaments attached to angles of the disk, widened at base, the others situated between the angles, their filaments not widened; anthers acute or short-acuminate; pistil 2 mm. long; styles 3–4, nearly wide-spreading, 3 times shorter than the ovary. V–VI.

In valleys and on gravelly banks of rivers and creeks. CAUCASUS: E. & S. Trans-Causasus. GEN. DISTRIB. Iran (N. Iran). Described from the neighborhood of the city of Khoi. Type in Leningrad.

2. **T. Meyeri** Boiss. Diagn. ser. I, 10 (1849) 9; Vol'f & Palib. Opr. Der. i Kust. 608; Roll. Dikorast. Rast. Kavk. 496; Reg. & Mlokoss. in Mat. Fl. Kavk. III, 9, 108; Medv. Der. i Kust. Kavk. 9; Gorshk. in Fl. S.E. V, 718; Grossh. Fl. Kavk. III, 77; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 78, 82; Rusan. Centr.-As. Tamar. 42.—*T. tetragyna* C. A. Mey. Verzeichn. (1831) 165; Ldb. Fl. Ross. II, p. 1 (1844–1846) 134, non Ehrenb.—*T. tetragyna* var. *Meyeri* Boiss. Fl. Or. I (1867) 768.—*T. tetragyna* var. *heterantha* f. *longibracteata* O. Ktze. in Tr. B. S. X (1887) 175.—*Myricaria dahurica* Krasn. in Izv. Russk. Geogr. Obshch. XXII (1886) 10, 50, non Ehrenb.; Schmalh. Fl. I, 167; Fedtch. & Fler. Fl. Eur. Russ. 638.—Ic.: Rusan. l. c. fig. 17, 4.—Exs.: Hb. R. F. no. 1417; Hb. F. SSSR no. 3049.

Shrub or small tree up to 3–4(5) mm. tall, with gray or brown-gray bark; leaves linear or lance-linear, 1–4.5 mm. long, 0.2–1 mm. wide, more or less elongate, obtuse, slightly inrolled, semiamplexicaule, with base somewhat widened, nearly cordate. Racemes lateral, simple, elongate, more or less broad, 5–13(15) cm. long, 4–8 mm. thick, dense, on peduncles 0.5–4 cm. long, the base with oblong, obtuse scales; bracts broadly linear, 3–4(5) mm. long, 0.5–0.7 mm. broad, acuminate, spreading, with base more or less widened, exceeding the calyx and sometimes more or less equalling the corolla (including the pedicel); pedicels 1–1.5 mm. long; flowers 4(5)-merous; calyx 2–2.5 mm. long, 1/3 shorter than the petals, its lobes ovate or ovate-lanceolate, 1.5–2 mm. long, 0.7–1.2 mm. wide, obtuse, broadly scarious-margined; petals white, pale rosy or rosy, oblong-oval or obovate-elliptic, 3–4 mm. long, 1.5 mm. wide, straight obtuse, inequilateral, nearly deciduous; disk 4 (rarely 6)-angled, mostly deep red; stamens 4 (rarely 6), equalling or slightly exceeding the petals, attached by the broad bases of the filaments to the angles of the disk; anthers more or less apiculate; pistil with bottle-[297] shaped, more or less thick ovary 1.5–1.8 mm. long, 0.7 mm. broad, and with 4 obovate-bottle-shaped, spreading styles 2½–3 times shorter than the ovary; capsule 5–7 mm. long, 2–3 mm. broad, nearly 2½ times longer than the calyx. IV–V. Pl. XV, fig. 8.

Banks of rivers, lakes, and seas, sandy-saline places, solonchak, solonets, and bottoms of former water-reservoirs. In mountains (along streams) extends to 1220 m. alt.—EUROP. SECT.: Lower Volga (at Kuma). CAUCASUS: Cis-Causasus, Dagestan, E. & S. Trans-Causasus, Tal. CENTR. ASIA: Kyz-Kum (S.W.), Kara-Kum, Mts. Turkmen., Amur-Darya, Syr-Darya, Pamiro-Alai. GEN. DISTRIB.: E. Mediterranean (N. Egypt, Palestine, W. Syria), Balkans-Asia Minor (Cyprus), Iran. Described from an island in the Caspian Sea. Type at Leningrad.

Economic Importance. Green twigs color leather with dark raspberry and cherry color (O. A. Enden in Tr. Turkm. Fil. AN SSSR vyp. V, 1944).

3. **T. elongata** Ldb.Fl. Alt. I (1829) 421; his Fl. Ross. II, 1, 133; Boiss. Fl. Or. I, 767; Pavl. Fl. Centr. Kazakhst. II, 454; Kryl. Fl. W. Sib. VIII, 1915; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 78, 82; Rusan. Centr.-As. Tamar. 44.—

Ic.: Ldb. Ic. Pl. Fl. Ross. III, tab. 254; Rusan. 1. c. fig. 17, 5.—Exs.: Hb. R. F. No. 1859; Hb. F. SSSR no. 3042; H. F. A. M. no. 312.

Shrub or small tree with yellowish or brownish gray bark, 1–3(5) m. tall; leaves broadly linear, lanceolate, or oblong-lanceolate, 1–9 mm. long, 0.3–3 mm. wide, acute, with broadly cordate base, auricled, semi-amplexicaule. Racemes lateral, simple elongate, 6–15(20) cm. long, 0.4–0.8 cm. thick, dense, on peduncles 1–2 cm. long, covered with oblong, obtuse scales; bracts linear, narrow, 3–6 mm. long, 0.3–0.7 mm. wide, acuminate, at the start of flowering slightly spreading, later recurved, equalling or exceeding the corolla (including pedicel); flowers 4(5)-merous; calyx 1.5 mm. long, ¼ shorter than the petals, with broadly ovate, narrowly scarious-margined lobes 1 mm. long, 0.3–0.7 mm. wide; petals pale or bright rosy or rosy violet (rarely white), oblong-oval or elliptic, 2–2.5 mm. long. 1–1.3 mm. wide, inequilateral, obtuse, reflexed, nearly deciduous; stamens 4 (rarely 6–7); disk 4 (rarely 6–7)-lobed, exceeding gradually the width of the widened bases of the filaments which nearly equal or slightly exceed the corolla; pistil with ovoid-oblong ovary 1.3–2 mm. long, and 3 very short styles 5–6 times shorter than the ovary; capsule 4–6 mm. long, 2 mm. broad, 2½–4 times longer than the calyx. IV–V. Pl. XV, fig. 1, 7.

Banks of streams, lakes, sandhills, solonets solonchak, solonets-clayey steppes; rarely found in mountains (to 1800 m.).—W. SIBERIA: Upper Tob. (Kustan. district Naurzum-karagai), Altai. CENTR. ASIA: [298] Aralo-Casp., Cis-Balkh., Kyz.-Kum, Kara-Kum, Amu-Darya, Syr-Darya, Pamiro-Alai, Tian-Shan (northern part). GEN. DISTRIB.: Dzh.-Kashg., Mong. (S.W.). Described from Mt. Arkaul, near Lake Zaisan. Type in Leningrad.

Note. A species resembling *T. Meyeri* Boiss. well distinguished from it by more elongate and narrower flowering racemes, linear, more or less narrowed bracts often exceeding the corolla (including pedicel); 3 short styles 5–6 times shorter than the ovary, and leaves with broadly cordate bases with auricles.

Ser. 2. **Tetrandrae** Gorschk.—Flowering racemes more or less elongate, up to 7 cm. long, 3–8 mm. thick; bracts triangular-lanceolate, shorter than the calyx, rarely equalling it; stamens 4 (rarely 5–6).

4. **T. tetrandra** Pall. in Neue Nord. Beitr. VII (1796) 430; Ldb. Fl. Ross. II, 1, 133; Bge. Tent. Gen. Tamar. sp. 28; Boiss. Fl. Or. I, 769; Schmalh. Fl. I, 168; Vol'f & Palib. Opr. Der. i Kust. 606; Reg. & Mlokoss. in Mat. Fl. Kavk. III, 9, 106; Medv. Der. i Kust. Kavk. 10; Grossh. Fl. Kavk. III, 77; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 85.—*T. taurica* Pall. Nova Acta Ac. Petrop. X (1797) 276.—*T. taurica* var. *octandra* Pall. 1. c. 276.—*T. brachystachys* Bge. Tentam. Gen. Tamar. spec. (1852) 26.—*T. tetrandra* f. *alba* Stev. et f. *rosea* Stev. in Bull. Soc. Nat. Mosc. (1856) 255.

Shrub or small tree 2–3 m. tall, with dark brown or black bark; leaves ovate-lanceolate or lanceolate, 1.5–2 mm. long, 0.5 mm. wide, acute, with narrow base, keeled, narrowly scarious-margined, appressed, not sheathing. Racemes lateral, solitary, few, 2–7 cm. long, 3–8 mm. thick, mostly sessile; bracts triangular-lanceolate or lanceolate, 1.3–2 mm. long, acute, with base more or less widened, longer than the pedicels, but shorter than the calyx, rarely equalling it; pedicels 0.5–1 mm. long, shorter than or equalling the calyx; flowers 4-merous, fragrant; calyx 1.3–2 mm. long, nearly ⅓ shorter than the petals, with ovate-oblong, acute lobes 1–1.5 mm. long; petals rosy or white, elliptic-concave, oblong, 2–2.5(3) mm. long, 0.9–1 mm. wide, mostly spreading, nearly deciduous; stamens 4 (rarely 5–6), disk 4 (rarely 5–6)-lobed, filaments attached to the lobes of the disk, with widened bases, equalling or little longer than the corolla; anthers ovoid, apiculate; pistil with ovary mostly

1–1.8 mm. long and 3(4) elongate-bottle-shaped spreading styles 2–3 times shorter than the ovary; capsule 5.5–6 mm. long, 1.7–2.5 mm. wide, 3–4 times exceeding the calyx. IV.

On banks of seas, rivers, creeks, and lakes. Planted in gardens. EUROP. SECT.: Bessarabia, Prichern. (Odessa), Crimea. CAUCASUS.: W. Trans-Cauc., S. Trans-Cauc. (at foot of Mt. Ararat, Aralykh.). GEN. DISTRIB.: W. Mediterranean (Istria, Pola), E. Medit. (W. Syria, Beirut), Balkans-Asia Minor [299] (S. Greece, E. Bulgaria, district Burgasa, Cyprus, N. Turkey). Described from Crimea. Type in Leningrad.

Economic Importance. Very ornamental and suitable for planting in dry alkaline places. In addition to seeds, it is easily multiplied by cuttings. Flowers in elongate inflorescences, good for bouquets (V. P. Maleev).

Note: From *T. Szovitsiana* Bunge distinguished by dark brown or black bark and leaves with narrowly scarious margin.

Ser. 3. **Laxiusculae** Gorschk.—Flowering racemes not large, mostly slender, 0.7–5 cm. long, 2–4(5) mm. thick, on peduncles covered with sparse scales; bracts oblong or ovate-lanceolate, equalling, shorter than, or longer than the pedicels; sometimes equalling or exceeding the calyx; stamens 4.

5. **T. araratica** (Bge.) Gorschk. in Soviet Bot. (1936) 4, 118; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 86.—*T. laxa* var. *araratica* Bge. Tentam. Gen. Tamar. Spec. (1852) 35; Reg. & Mlokoss. in Mat. Fl. Kavk. II, 9, 105.

Shrub with brown bark, 1–2 m. tall; leaves ovate-oblong, nearly rhombic, 1–2 mm. long, 0.5–1 mm. wide, acute, decurrent, with keeled base. Racemes lateral, solitary, slender, more or less elongate, 1–4(5) cm. long, 3–4 mm. wide, when expanded nearly sessile or on short peduncles 4 mm. long; bracts oblong, 1–1.5 mm. long, 0.7 mm. wide, obtuse, mostly longer than the pedicels, which equal or sometimes exceed the calyxes; flowers 4-merous; calyx 0.7–1 mm. long, twice shorter than the petals, its lobes triangular-ovate, 0.5–0.7 mm. long, 0.5 mm. wide, acute, broadly scarious-margined; petals rosy, oblong-elliptic, 1.5–2 mm. long, 0.5–1 mm. wide, deflexed; stamens 4, disk 4-angled, exceeding the more or less widened bases of the filaments, which are mostly 1½ longer than the corolla, sometimes not with widened base; anthers obtuse; styles 3 (rarely 4), 4–5 times shorter than the ovary. IV. Pl. XV, fig. 5.

River valleys. CAUCASUS: S. Trans-Cauc. (valley of the River Argura near Erevan). Endemic. Described from the stated locality. Type in Leningrad.

NOTE. From *T. Szovitsiana* Bge., one of whose forms F. N. Rusanov considered *T. araratica* to be, the latter is distinguished by: ovate-oblong, nearly rhombic leaves; slender (twice as slender) flowering racemes when expanded; oblong, broadly scarious-margined bracts not coriaceous above; smaller flowers; obtuse anthers and styles 3 in number, (rarely 4).

6. **T. Litwinowii** Gorschk. in List Pl. Herb. Fl. SSSR, X, vyp. LXI–LXIV (1936), 24; same in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 85.—*T. laxa* var. *parviflora* Litw. in List Pl. Hb. R. Fl. [300] V (1905) 79.—*T. Szovitsiana* Rus. Tr. Turkm. Fil. AN SSSR, V (1944) 35, non Bge.—Ic.: Rusan. Centr.-As. Tamar. fig. 13, 2.—Exs.: Hb. R. F. no. 313; Hb. F. SSSR no. 3048.

Shrub or small tree brown or (on young twigs) brownish red bark, 2–3 m. tall, widely branched; leaves ovate-oblong, 1–2 mm. long, 0.5 mm. wide, acute, decurrent, with keeled base, narrowly scarious-margined, semiamplexicaule. Racemes lateral, solitary or developing in bunches, 0.7–2(2.5) cm. long, 0.2–0.3(0.4) cm. thick, slender, few, nearly sessile or on short peduncles 2–5 mm. long, covered with sparse, brown-based scales; bracts ovate-lanceolate, 0.7–1 mm. long, 0.3–0.7 mm. wide, acute, equalling or longer than the pedicels, which equal or are shorter than

the calyxes; flowers 4-merous; calyx 0.7–1 mm. long, with ovate-triangular lobes 0.7 mm. long, 0.5–0.7 mm. wide, acute, with broadly scarious-margined lobes; petals rosy or scarlet or dark rosy, oblong, 1–1.3 mm. long, 0.5–0.7 mm. wide, ⅓ longer than the calyx, obtuse, deflexed; stamens 4; disk 4-lobed, dark red, exceeding the widened bases of the filaments, these equalling or sometimes exceeding the corolla; anthers obtuse; styles 3 (rarely 4), short, 4–5 times shorter than the ovary; capsule 3 mm. long, 1 mm. broad, from base nearly 3–4 times longer than the calyx. III–IV. Pl. XV, fig. 3.

On banks of streams and lakes, by wells and on coastal sands. CENTR. ASIA: Aralo-Caspia (city Kzyl-orda), Cis-Balkh. (Bedpak-dala), Kyz.-Kum (delta of Amu-Darya), Kara-Kum, Gorn. Turkm., Syr-Darya, Pamiro-Alai. GEN. DISTRIB.: Iran (N. Iran). Described from Farada in Amu-Darya. Type in Leningrad.

NOTE. F. N. Rusanov separates *T. Litwinowii* from *T. Szovitsiana*, with which decision I concur, since *T. Szovitsiana* is well distinguished by its large, nearly cylindric, dense, thick flowering racemes 2.5–4 cm. long, 0.6–0.8 cm. thick (mostly 1½–2 times as thick), and its big flowers (2–2½ times as large). *T. Szovitsiana* occurs in N.W. Iran (reported from Prov. Azerbaijan, distr. Khoi), while *T. Litwinowii* occurs in Central Asia and E. Iran. *T. Litwinowii* was studied by us closely in nature in its massive stands along the Rivers Amu-Darya, Murgab, and Tedzhen in the Turkmenian SSR in 1930.

7. **T. Androssowii** Litw. in List of Pl. Hb. R. F. V (1905) 41; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 85; Rusan. Centr.-As. Tamar. 30.—Ic.: Rusan. l. c. fig. 13, 1.—Exs.: Hb. R. F. no. 1317.

Arborescent shrub 5 m. tall, with reddish brown bark; leaves ovate or oblong-ovate, 1–2.5 mm. long, 0.3–0.5 mm. wide, acute, strongly inrolled toward apex, with narrowly scari- [301] ous margin, with sharply decurrent base, nearly amplexicaule. Racemes lateral, solitary or developing in bunches, commonly with slender branchlets, more or less narrow, 2–3(5) cm. long, 3–4(5) mm. thick, on peduncles 0.5–1 cm. long, covered with sparse, bract-like scales; bracts oblong, 0.7–1 mm. long, shorter than the pedicels, with coriaceous, strongly inrolled, awl-shaped apex; pedicels 1–1.5 mm. long, shorter than the calyx; flowers 4-merous; calyx 0.7–1 mm. long, ⅓ shorter than the petals, with ovate, acute, broadly scarious-margined lobes 0.5–0.7 mm. long, 0.5 mm. wide; petals white, obovate, 1–1.5 mm. long, 0.7 mm. wide, spreading, nearly deciduous; stamens 4; disk 4-angled, exceeding the widened bases of the filaments, which equal or slightly exceed the corolla; anthers cordiform, apiculate, purple or partly yellow; styles 3 (rarely 4), flask-shaped, short, mostly 3–4 times shorter than the ovary; capsule 4–5 mm. long, 1 mm. broad (at base), nearly 4 times exceeding the calyx. IV.

Clayey solonets depressions, loose sands, banks of lakes and streams. CENTR. ASIA: Kyz.-Kum (sect. Kulau-khak), Kara-Kum, Gorn. Turkm. Endemic. Described from Farada on the River Amu-Darya. Type in Leningrad.

8. **T. Kotschyi** Bge. Tentam. Gen. Tamar. Spec. (1852) 30; Boiss. Fl. Or., I, 770; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 78, 84; Rusan. Centr.-As. Tamar. 32.—*T. tetrandra* var. *parviflora* Boiss. in Kotschy, Pl. Pers. austr. no. 100.—*T. Kotschyi* var. *rosea* Litw. in Tr. Bot. Mus. AN, III (1907) 112.—Ic.: Rusan. l. c. fig. 15, 8.

Arborescent shrub with gray-brown bark, 2 m. tall; leaves broadly ovate, 1–2 mm. long, 1–1.5 mm. wide, acute, with coriaceous white margin, angled at base, semiamplexicaule. Racemes simple, lateral, solitary, 1–4 cm. long, 3–5 mm. thick, more or less scanty, on short peduncles 3–5 mm. long, densely covered with ovate-lanceolate, acute scales; bracts ovate or ovate-lanceolate, keeled, 1.5–2.5 mm. long,

acute, equalling or exceeding the calyx (including pedicel); pedicel equalling the calyx; flowers 4-merous; calyx 0.7–1 mm. long, nearly twice shorter than the petals, its lobes broadly ovate-rhombic, 0.5–0.7 mm. long, 0.5 mm. wide, acute, scarious-margined; petals rosy or white (very rarely yellowish), oblong-obovate, 1.7–2 mm. long, 0.7–1 mm. wide, obtuse, spreading, deciduous; stamens 4; disk 4-lobed, exceeding the widened filament-bases, filaments equalling or somewhat longer than the corolla; anthers obtuse; pistil with conical ovary 0.8–1 mm. long and 3 (rarely 4) short, ob- [302] ovate, deflexed styles 3–4 times shorter than the ovary; capsule 2.5–4 mm. long, 1.5 mm. wide, nearly 4 times longer than the calyx. IV.

On stream banks. CAUCASUS: S. & E. Trans-Cauc. CENTR. ASIA: Kara-Kum (Farad), Gorn. Turkm., Pamiro-Alai. Gen. DISTRIB.: Iran. Described from S. Iran, near Gera. Type in Leningrad.

Ser. 5. **Laxae** Gorschk.—Flowering racemes more or less shortened, thick, 0.5–2.5(3) cm. long, 4–9 mm. thick; bracts oblong or oblong-lanceolate, 2–3 times shorter than the pedicels; stamens 4 (5–6).

9. **T. laxa** Willd. in Abh. phys. Kl. Preuss. Acad. Wissensch. (1812–1813) ed. 1816, 82; Ldb. Fl. Alt. I, 422; his Fl. Ross. II, 1, 133; Bge. Tentam. Gen. Tamar. spec. (1852) 35; Boiss. Fl. Or. I, 770; Schmalh. Fl. I, 168; Kryl. Fl. Alt. II, 446; Roll. Dikorast. Rast. Kavkaza, 496; Vol'f & Palib. Opr. Der. i Kust. 606; Reg. & Mlokoss. in Mat. Fl. Kavk. III, 9, 103; Medv. Der. i Kust. Kavk. 11; Gorschk. in Fl. S.-E. V, 718; Grossh. Fl. Kavk. III, 75; Pavl. Fl. Centr. Kazakhst. II, 464; Kryl. Fl. W. Sib. VIII, 1015; Gorschk., Bot. Mat. Herb. Bot. Inst. AN SSSR VII, 4, 79, 84; Gorschk. in Maevsk. Fl. ed. 7, 513; Rusan. Centr.-As. Tamar. 37.—*T. laxa* var. *transcaucasica* Bge. Tentam. Gen. Tamar. Spec. (1852) 35.—*T. Pallasii* Desv. in Ann. Sci. Nat. 1 ser. IV (1825) 343; Litv. in List Pl. Hb. R. F. VI, 102.—Ic.: Paulsen, Stud. Veg. Pamir, 210; Fl. S. E. fig. 488; Rusan. l. c. fig. 15, 9.—Exs.: Hb. R. F. no. 1961, 1962.

Shrub with red-brown, chestnut-brown, or grayish bark, 2–3 m. tall; leaves ovate-oblong, nearly rhombic, 1–2(4) mm. long, 0.5(1.5) mm. wide, acute, narrowly scarious-margined; decurrent, with keeled base. Racemes lateral, few, short, broad, solitary, sometimes bunched, 1–2.5(3) cm. long, 4–7 mm. thick, or strongly contracted, 0.5–1.2 cm. long, 4–9 mm. thick (var. *vulgaris* Bge.), nearly sessile or on short peduncles 2.5–3 mm. long, covered with sparse, oblong, brown scales; bracts ovate-lanceolate or oblong, 1–1.2 mm. long, more or less acute, scarious-margined, coriaceous toward apex, mostly inrolled, 2–3 times shorter than the pedicels; pedicels 1.8–2(2.8) mm. long, 2–3 times longer than the calyx;[3] flowers 4(5)-merous; calyx 0.7–0.9 mm. long, twice shorter than the petals, its lobes broadly obovate, reflexed, 0.5–0.7 mm. [305[4]] long, 0.5–0.7 mm. wide, acute, broadly scarious-margined; petals oblong-oval or oblong-obovate, spreading, white or rosy, 1.7–2 mm. long, 1 mm. wide, deciduous; stamens 4 (5–6); disk 4(6)-angled, exceeding the widened bases of the filaments, which equal or slightly exceed the corolla; anthers cordiform,

[3] In the original this description of the pedicels precedes that of the bracts; it has here been shifted to its appropriate position. (Translator's Note.)
[4] Page 303 is occupied by Pl. XV, p. 304 is blank. (Translator's note.)

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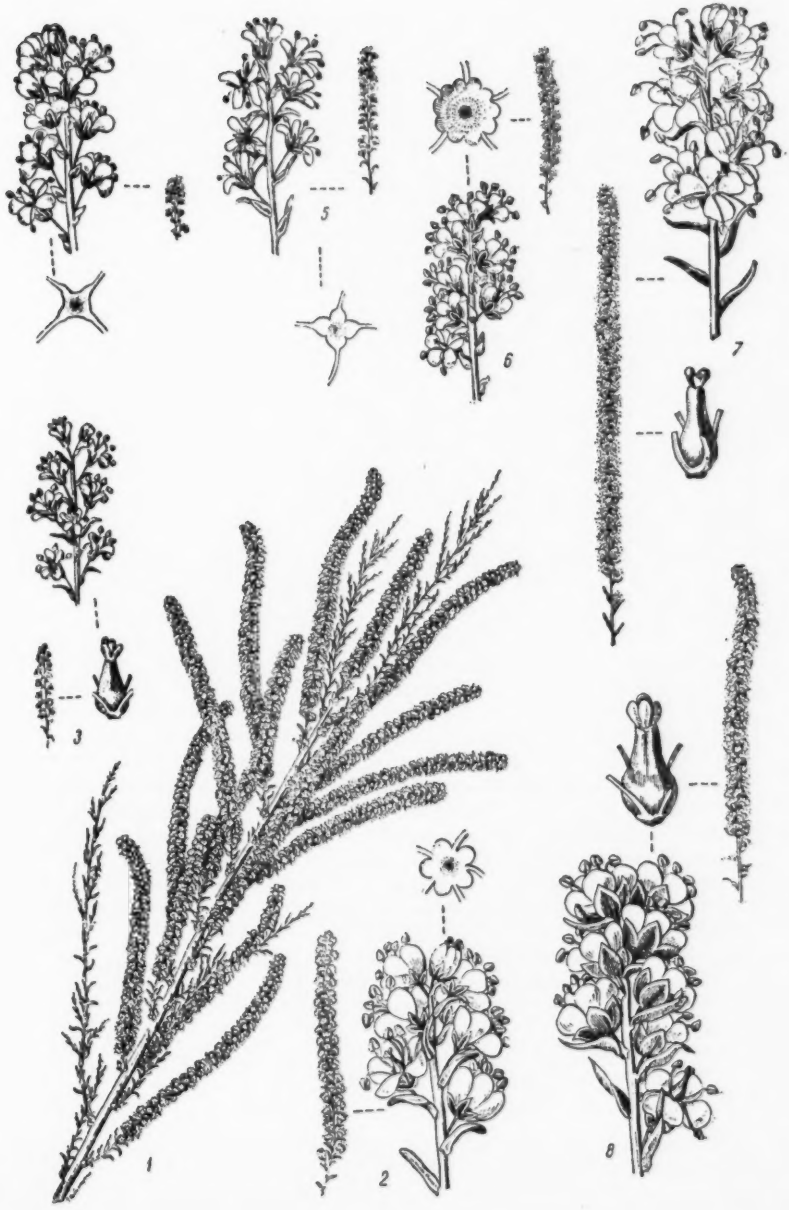
[302] EXPLANATION OF PLATE XV.

1. Tamarix elongata Ldb., infl.—2. T. Hohenackeri Bge., part of infl., detail of same, disk.—3. T. Litwinowii Gorschk., part of infl., detail of same, fl., pistil.—4. T. laxa Willd., part of infl., detail of same, disk.—5. T. araratica (Bge.) Gorschk., part of infl., detail of same, disk.—6. T. florida Bge., part of infl., detail of same, disk.—7. T. elongata Ldb., part of infl., detail of same, pistil.—8. T. Meyeri Boiss., part of infl., detail of same, pistil.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short-apiculate, red-violet; styles 3 (rarely 4), obcordiform-vasiform, 3–4 times shorter than the ovary; capsule 4–6(7) mm. long, 1 mm. broad, 5–6 times longer than the calyx. III–V. Pl. XV, fig. 4.

On solonchak, solonets, sands, sandy steppes, on banks of streams, seas, and lakes. EUROP. SECT.: Lower Don, Lower Volga. CAUCASUS: Cis-Cauc., E. Trans-Cauc. W. SIB.: Irt., Altai. CENTR. ASIA: Aralo-Caspia, Cisbalkh., Kyz.-Kum., Kara-Kum., Gorn. Turkm., Amu-Darya (near Olota and south of Kara-Kulya), Syr-Darya, Pamiro-Alai (distr. Gissara, Lake Tuz-Kane, basin Senzara). GEN. DISTRIB.: Iran, Mongolia (S.W. part). Described from the region between Krasnoarmeisk (Sarepta) and the Caspian Sea. Type was in Berlin.

Note. From the related *T. gracilis* Willd., distinguished by the shorter and broader lateral flowering racemes, ovate-lanceolate or oblong bracts 2–3 times shorter than the pedicels, and capsule 5–6 times longer than the calyx.

Ser. 5. **Floridae** Gorschk.—Flowering racemes mostly long, 5–9 cm. long, flowers 5-merous, bracts broadly ovate or linear-oblong, longer than the pedicels, but not exceeding the calyxes. Stamens 5.

10. **T. Hohenackeri** Bge. Tentam. Gen. Tamar. spec. (1852) 44; Boiss. Fl. Or. I, 771; Schmalh. Fl. I, 169, excl. syn.; Reg. & Mlokoss. in Mat. Fl. Kavk. III, 9, 99; Grossh. Fl. Kavk. III, 76; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 86; Rusan. Centr.-As. Tamar. 72.—*T. angustifolia* Hohen. in Bull. Soc. Nat. Mosc. (1838) 363, non Ldb.—*T. Hohenackeri* f. *frondosa* Lipsky in Zapisk. Kievsk. Obshch. XII, 2 (1892) 10.—*T. Hohenackeri* var. *glandulosa* Rgl. & Mlokoss. and var. *pontica* Rgl. & Mlokoss. and var. *taurica* Rgl. & Mlokoss. and f. *iberica* Rgl. & Mlokoss. in Mat. Fl. Kavk. III, 9 (1909) 101, 102.—*T. Hohenackeri* var. *ferganica* Drobov in Herb. no. 966.—Ic.: Rusan. l. c. fig. 13, 3.—Exs.: Hb. R. F. no. 1959; Hb. F. SSSR no. 3045.

Shrub or small tree 1–3(5) m. tall with brown-red bark; leaves lanceolate, 1–5 mm. long, 0.5–1 mm. wide, acute, inrolled, broadened at base, decurrent, nearly amplexicaule. Racemes lateral, solitary or developing in bunches, elongate, 1.5–9 cm. long, 3–5(8) mm. thick, few, on peduncles 0.5–2 cm. long; bracts linear-oblong, 1–2 mm. long, obtuse, exceeding the pedicels (slightly shorter than the calyxes) or rarely equalling the calyxes (including pedicels), keeled; pedicels 0.5–1.5 mm. long; flowers 5-merous; calyx 1.3–1.5 mm. long, mostly 1/3 shorter than the petals, with ovate, acute, [306] scarious-margined lobes 0.8–1 mm. long, 0.5 mm. wide; petals ovate-elliptic, erect, rosy, 2–2.5 mm. long, 0.7–1 mm. wide, mostly persistent; stamens 5; disk 5-lobed, lobes deeply indented, filaments distinct, nearly equalling or 1/3 exceeding the corolla, inserted between the lobes of the disk; anthers cordiform, obtuse; styles 3 (rarely 4), capitate-lobed, 2–3 times shorter than the ovary; capsule 4–5 mm. long, 3 times longer than the calyx. IV–V. Pl. XV, fig. 2.

Coastal sands, solonchak and solonets, shores of seas; in mountains reaches 900 m. EUROP. SECT.: Crimea, Lower Volga (between Volga and Ergenyame, il'men'[5] Beskul'). CAUSASUS: Cis-Cauc., Dag., W. E. & S. Trans-Cauc., Tal. CENTR. ASIA: Aralo-Casp. (Kzyl-orda), Cis-Balkh., Kara-Kum., Gorn.-Turkm., Amu-Darya, Syr-Darya, Pam.-Al., Tian-Shan. GEN. DISTRIB.: Iran (N. Iran, Astrabad prov., W. Iran, Iranian Plateau). Described from Khanlara (near Elenendorf). Type in Leningrad.

Economic Importance. Green twigs stain leather with dark raspberry or cherry color. (O. A. Enden in Tr. Turkm. Fil. AN SSSR, V, 1944).

11. **T. florida** Bge. Tentam. Gen. Tamar. spec. (1852) 37; Pavl. Fl. Centr.

[5] This word is not in the three Russian-English dictionaries at hand. Similiar words refer to elm trees, the ore titanium, and mud or ooze. (Translator's note.)

Kazakhst. II, 464; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII 4, 79, 86; Rusan. Centr.-As. Tamar. 64.—*T. florida* var. *rigida* Bge. Tentam. Gen. Tamar. spec. (1852) 38–40.—*T. ashkabadensis* Freyn et Sint. in Bull. Herb. Boiss. 2. ser. III (1903) 1059.—Ic.: Rusan. 1. c. fig. 20, 17.—Exs.: Hb. R. F. no. 1419; Hb. F. SSSR no. 3044.

Shrub or tree 4–6 m. tall, with purple-red bark; leaves broadly ovate or broadly cordate, 0.5–1 mm. long, 0.5 mm. wide, decurrent, nearly amplexicaule, coriaceous-margined, at apex acute, inrolled. Racemes lateral, simple, solitary, long, slender, 1–5 cm. long, 3–4 mm. thick, densely arranged on the branches; pedicels 2–5 mm. long; bracts broadly ovate, 1–1.5 mm. long, coriaceous toward apex, acute, longer than the pedicels but not exceeding the calyxes, scarious-margined; pedicels 0.5–1 mm. long, shorter than the calyx; flowers 5-merous; calyxes 1–1.4 mm. long, nearly 1/3 shorter than the petals, with ovate-rhombic, acute, scarious-margined lobes 0.5–1 mm. long, 0.5 mm. wide; petals ovate or oblong, rosy or white (var. *albiflora* Bge.), 1.8–2 mm. long, 0.8 mm. wide, becoming deflexed, mostly deciduous; stamens 5; disk mostly 10-angled, filaments slender, long, 1½ times exceeding the corolla, attached between the angles of the disk; anthers mostly obtuse; styles 3, obovoid, more or less 4–5 times shorter than the ovary; capsule 2–2.5 mm. long, 0.7–1 mm. wide, nearly twice longer than the calyx. IV–VI. Pl. XV, fig. 6.

Banks and valleys of rivers, creeks, and lakes, sandy and clayey places. CAUCASUS: E. and S. Trans-Cauc. CENTR. ASIA: Aralo-Casp., Cis-Balkh., Kyz.-Kum., [307] Kara-Kum., Gorn.-Turkm., Syr-Darya, Pam.-Al., Tian-Shan. GEN. DISTRIB.: Iran, Dzh.-Kashg. Described from Gusseinona, near Dzhen-daka in Iran. Type in Leningrad.

Sect. 2. **Aestivales** Bge. Tentam. Gen. Tamar. spec. (1852) 41.—Flowering racemes on new growth, terminal, mostly late-blooming, rarely lateral, flowers mostly 5-merous (rarely 4-merous).

Ser. 1. **Graciles** Gorschk.—Flowering racemes mostly terminal, rarely lateral, (0.5)1–3(6) cm. long, 3–4(5) mm. thick; flowers 4–5-merous; stamens 4–5; disk mostly 4–5-angled, exceeding the widened filament bases.

12. **T. gracilis** Willd. Abhand. physik. Kl. Preuss. Akad. Wissensch. (1812–1813) ed. 1816, 81; Ldb. Fl. Ross. II, 1, 134; Boiss. Fl. Or. I, 772; Fedtch. & Fler. Fl. Eur. Russ. 638; Roll. Dikor. R. Kavk. 496; Medb. Der. i Kust. Kavk. 11; Pavl. Fl. Centr. Kazakhst. II, 465; Gorschk. in Fl. S.E. V, 720; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 88; Rusan. Centr.-As. Tamar. 51.—*T. cupressiformis* Ldb. Fl. Alt. I (1829) 423; Fl. Ross. II, 1, 134; Pavl. Fl. Centr. Kazakhst. II, 464, 466; Kryl. Fl. W. Sib. VIII, 1916; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 89.—*T. angustifolia* Ldb. in Eichw. Pl. nov. casp.-cauc. II (1831–1833) 12; his Fl. Ross. II, 134.—*T. polystachya* Ldb. Fl. Ross. II, 1 (1844–1846) 133.—*T. laxa* var. *occidentali-caspica* Bge. et var. *macrantha* Bge. et var. *polystachya* Bge. Tentam. Gen. Tamar. spec. (1852) 35.—*T. laxa* Schmalh. Fl. I (1895) 168, non Willd. p. p.—*T. Spiridonowii* B. Fedtsch. in Bot. Mat. Herb. Glavn. Bot. Sada, III, 44–48 (1922) 182.—*T. tetrandra* auct. Fl. USSR, non Pall.—Ic.: Ldb. in Eichw. tab. 8; Ldb. Ic. pl. Fl. Ross. III, tab. 253; Rusan. 1. c. fig. 15, 7.

Shrub 3–4 m. tall with purple- or gray-brown or brownish-chestnut bark; leaves lanceolate-linear, ovate-lanceolate or ovate, 1–4 mm. long, 0.5–1(2) mm. wide, acute, with decurrent base, sometimes auricled. Racemes rarely lateral, mostly terminal, 1–4(6) cm. long, 3–4(5) mm. thick, simple, short panicles; bracts lanceolate-subulate or subulate, 1.5–2 mm. long, acute, mostly nearly equalling or shorter than the calyxes (including pedicels), with a small hump at base and mostly with small auricles; pedicels 0.5–1.5(2) mm. long; flowers 4–5-merous; calyx 1–1.5 mm. long, mostly 1½–2½ times shorter than the petals, with ovate, obtuse, broadly scarious-

margined lobes 0.5–1 mm. long and 0.5 mm. wide; petals obovate-elliptic or obovate-oblong, 1.5–2.5(3) mm. long, (0.7)1–1.5 mm. wide, rosy, spreading, deciduous; stamens 4–5, disk mostly 4–5-angled, filaments widened at base, attached to the angles [308] of the disk, equalling or 1½ times exceeding the corolla; anthers apiculate; mostly purple or violet-rosy; styles 3 (rarely 4), short, 4 times shorter than the ovary; capsule 4–6 mm. long, 2 mm. broad, nearly 4 times longer than the calyx. V–VI.

On banks of rivers, lakes, seas, and bays; on clayey and solonets steppes, on solonchak, on dune and loose hilly sands. EUROP. SECT.: Lower Don (River Manych, northeastern shore of the Sea of Azov), Lower Volga. CAUSASUS: Dag. (near Derbenta, Makhach-kala, shore of Lake Akh-tel'). W. SIB.: Upper Tob. (Chkalov distr., between Irgiz and Chkalov), Irt., Alt. CENTR. ASIA: Aralo-Casp., Cis-Balkh. GEN. DISTRIB.: Mongolia (N.W.). Described from banks of the River Irtysh. Type in Berlin.

13. **T. leptopetala** Bge. Tentam. Gen. Tamar. spec. (1852) 72; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 89.—*T. leptopetala* var. *karabachensis* Rgl. & Mlokoss. in Mat. Fl. Fl. Kavk. III, 9 (1909) 103.

Shrub with reddish purple bark; leaves ovate, nearly rhombic, 1–1.5 mm. long, 0.5–0.7 mm. wide, acute, scarious-margined, nearly amplexicaule, with decurrent bases. Racemes lateral and terminal, simple, short, 0.5–2 cm. long, 4 mm. thick, on peduncles 2–3 mm. long, covered with sparse scales; bracts ovate, 0.7–1 mm. long, acute, longer than the pedicels or equalling them; pedicels short, 0.5–0.7 mm. long, shorter than the calyxes; flowers 4–5-merous; calyx 1 mm. long, its lobes ovate-rhombic, 0.5–0.7 mm. long, 0.5 mm. wide, acute, scarious-margined; petals spatulate-oblong or oblong-linear, narrow, 1.5 mm. long, 0.5 mm. wide, obtuse, spreading, nearly persistent; stamens 4–5; disk 4–5-angled, exceeding the widened filament bases; anthers obtuse; pistil with 3 short styles. V.

CAUSASUS: E. Trans-Cauc. (near Khudoferinsk). GEN. DISTRIB.: Iran (N. Iran). Described from the valley of the River Lura in the southern part of the Elburz. Type in Paris.

Ser. 2. **Hispidae** Gorschk.—Plant all covered with erect, short hairs; stamens 5; disk 5-angled, exceeding the widened bases of the staminal filaments.

14. **T. hispida** Willd. Abhandl. physik. Kl. Akad. Wissensch. (1812–1813) ed. 1816, 77; Ldb. Fl. Ross., II, 1, 135; Bge. Tentam. Gen. Tamar. spec. 69; Boiss. Fl. Or. I, 776; Schmalh. Fl. I, 168; Pavl. Fl. Centr. Kazakhst. II, 465, 468; Gorschk. in Weedy Plants SSSR, III, 300; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 79, 88; Rusan. Centr.-As. Tamar. 56.—*T. pentandra* var. Pall. Fl. Ross. I, II (1784) 72, excl. tab. 79.—*T. tomentosa* Smith in Rees Cycl. XXXV (1819) 35.—*T. canescens* Desv. in Ann. Sc. Nat. ser. I, IV (1825) 348.—*T. hispida* var. *genuina* Bge. [309] Tentam. Gen. Tamar. spec. (1852) 69.—*T. Karelini* var. *hirta* Litw. in List Pl. Hb. R. F. V (1905) 79.—*T. Lipskyi* Gandoger in Bull. Soc. Bot. Fr. XVIII, ser. 4 (1918) 27.—*T. hispida* f. *internodiis abbreviatis* Eug. Kor. et f. *Internodiis elongatis* E. Kor. in Sched. ad Herb. Fl. As. Med. fasc. XIII (1927) 44.—Ic.: C. K. Schn. Laubholzk. II, 342; Paulsen, Stud. Veg. Pamir. 212; Rusan. l. c. fig. 22, 11.—Exs.: Hb. R. F. no. 1420; H. F. A. M. no. 311 a, b.

Shrub or small tree 1.5–5 m. tall, with brown-red bark or on young twigs light red bark, all densely covered with 1-celled erect short hairs; leaves broadly cordate-ovate, 0.5–2 mm. long, 0.5–0.7 mm. wide, acute, not decurrent, subauriculate, semi-amplexicaule. Racemes terminal, mostly drooping, (1.5)4–7 cm. long, 3–5 mm. thick, or very long, 7–17 cm. long, 2–4 mm. thick [var. *hirta* (Litw.) Gorschk.], in dense more or less compound panicles; bracts ovate-cordate, 1–1.5 mm. long, nearly

equal or sometimes slightly exceeding the calyx (including pedicel); pedicels 0.5–0.7 mm. long, shorter than the calyx; flowers 5-merous; calyx 1–1.3 mm. long, 1/3 shorter than the petals; with angled-ovate lobes 0.5–1 mm. long, 0.5 mm. wide, acute, sometimes in upper part colored violet-red; petals oblong-elliptic, rosy or red, 1.5–2 mm. long, 0.6–1 mm. wide, spreading, deciduous; stamens 5; disk 5-angled, exceeding the widened bases of the filaments, which nearly equal or slightly exceed the corolla; anthers obtuse; styles 3, short, obovoid, mostly 3 times shorter than the ovary; capsule 4–5(7) mm. long, 1 mm. wide, slender, red or violet-red, 4–5 times longer than the calyx. VII–IX. Pl. XVI, fig. 2.

Salt deserts, damp and soft solonchak, solonets, saline margins and low sandhills, banks and valleys of streams, lakes, and alkali flats. In mountains rarely, to 500 m.—EUROP. SECT.: Lower Volga (Gur'ev). CENTR. ASIA: Aralo-Casp., Cis-Balkh., Kyz.-Kum., Kara-Kum., Syr-Darya, Pam.-Al., Tian-Shan. GEN. DISTRIB.: Mongolia, Japan-China. Described from shore of the Caspian Sea. Type was in Berlin.

Economic Importance. Occurs as a weed in rice-irrigation channels.

Note. *T. hispida* var. *pleiandra* Bge. is a hybrid, *T. hispida* Willd. × *T. passerinoides* Delile (Rusan., Centr.-As. Tamar., 57).

Ser. 3. **Bungeanae** Gorschk.—Flowering racemes spiciform, dense, not long, 0.7–3 cm. long, 3–4(5) mm. thick, in compound panicles; stamens 5; disk 5-lobed, with slender staminal filaments attached to the lobes.

15. **T. Bungei** Boiss. Fl. Or. I (1867) 774; Rusan. Centr.-As. Tamar. 61.—*T. Ninae* Gorschk. in Soviet Botany (1936) 4, 117; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 80, 90.—Ic.: Rusan. 1. c. fig. 21, 14. [310] Shrub or small tree with red-brown bark, 5–6 m. tall; leaves ovate, 1–1.5 mm. long, 0.5–1 mm. wide, acute, decurrent, semiamplexicaule. Racemes terminal, spicate, dense, 0.7–3 cm. long, 3–4(5) mm. thick, nearly sessile on short peduncles 0.5 cm. long, in compound panicles; bracts lanceolate, 0.7–1 mm. long, equalling or shorter than the calyxes (including pedicels), acute, scarious-margined; pedicles 0.3–0.5 mm. long, 2–3 times shorter than the calyx; flowers 5-merous; calyx 1–1.5 mm. long, with ovate, obtuse, broadly scarious-margined bracts 1 mm. long, 0.5 mm. wide; petals oblong-ovate, rosy, 1.5–2 mm. long, 0.5–1 mm. wide, obtuse, ¼ longer than the calyx, nearly deciduous; stamens 5; disk 5-lobed, with slender filaments attached to the lobes, somewhat exceeding the corolla; anthers obtuse; pistil with oblong-ovoid ovary 0.8–1 mm. long and 3 short styles 2–3 times shorter than the ovary; capsule 4.5 mm. long, 1.2 mm. wide, 3–4 times longer than the calyx. V–VIII.

Low places with clay bottom in sandy desert areas, "uzboi" (dry valleys) in sand.—CENTR. ASIA: Kyz.-Kum., Kara-Kum., Syr-Darya. GEN. DISTRIB.: Iran. Described from Kefterkhan, between Kerman and Iezd in Iran. Type in Leningrad.

Ser. 4. **Micranthae** Gorschk.—Flowering racemes slender, simple, elongate, 4–15 cm. long, 2–3 mm. thick, in dense, compound panicles; disk 5-angled, exceeding the widened bases of the staminal filaments.

16. **T. leptostachys** Bge. in Mem. Acad. Sc. Petersb. VII (1854) 293; Boiss. Fl. Or. I, 776; Pavl. Fl. Centr. Kazakhst. II, 466, 470; Kryl. Fl. W. Sib. VIII, 1917; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII 4, 80, 92; Rusan. Centr.-As. Tamar. 58.—*T. ramosissima* Bong. et Mey. in Mem. Acad. Sc. Petersb. VI ser. IV (1845) 190, non Ldb.—*T. gallica* var. *micrantha* Ldb. Fl. Ross. II, 1 (1844–1846) 135, p. p.—Ic.: Rusan. 1. c. fig. 21, 13 and fig. 22, 12.

Shrub with reddish gray bark, 1–2(4) m. tall and with more or less appressed branches; leaves narrowly ovate or ovate-lanceolate, 1–4(6) mm. long, 0.5–3(4) mm. wide, acute, decurrent. Racemes slender, elongate, 4–12 cm. long, 2–3 mm. thick, simple, on peduncles 0.5–2.5(5.5) cm. long, in dense compound panicles; bracts

nearly subulate, 1–1.5 mm. long, acuminate, equalling or exceeding the pedicels, which are equal to or slightly longer than the calyxes; flowers 5-merous; calyx 0.7–0.9 mm. long with ovate, acute, narrowly scarious-margined lobes 0.5–0.6 mm. long, 0.4 mm. wide; petals obovate, rosy, 1.5 mm. long, 0.5 mm. wide, obtuse, twice longer than the calyx, half opened, deciduous; stamens 5; disk 5-angled, exceeding the widened bases of the filaments, these 1½–2 times longer than the corolla; anthers not apiculate; styles 3, short, 4–5 times shorter than the ovary, obovoid; [311] capsule 1.8 mm. long, 0.5 mm. wide, twice longer than the calyx. V–IX. Pl. XVI, fig. 5.

Banks of rivers, lakes, and seas, in solonets and clay steppes and low places among sand hills.—CENTR. ASIA: Aralo-Casp., Cis-Balkh., Kyz.-Kum., Kara-Kum., Gorn.-Turkm., Syr-Darya, Tian-Shan. GEN. DISTRIB.: Mongolia (S.W.). Described from the southern part of the sandy M. Barsuka near the Aral Sea. Type in Leningrad.

Ser. 5. **Ramosissimae** Gorschk.—Flowering racemes 1–6(9) cm. long, 3–5 mm. thick, in open or more or less dense panicles; stamens 5; disk 5-lobed, 10-lobed, or 10-angled; staminal filaments attached between the lobes or angles of the disk.

17. **T. ramosissima** Ldb. Fl. Alt. I (1829) 424; Ic. Pl. Fl. Ross. III, 17; Gorschk. in Fl. S.E. V, 720; Pavl. Fl. Centr. Kazakhst. II, 465, 468; Gorschk. in Weedy Pl. SSSR, III, 300; Forschk. in Bot. Mat. Herb. Inst. Bot. AN SSSR, VII, 4, 80, 93; Gorsch. in Maevski Fl. ed. 7, 514; Rusan. Centr.-As. Tamar. 76.—*T. pentandra* Pall. Fl. Ross. I, II (1788) 72, p. p. non tab. 79; Kryl. Fl. W. Sib. VIII, 1916.—*T. Pallasii* auct. non Desv. (1824) sensu DC. Prodr. III (1828) 26; Bge. Tentam. Ge. Tamar. spec. (1852) 49; Boiss. Fl. Or. I, 773; J. Gay in Blanche et Gaillardo Catal. de l'herb. de Syrie, 10, ex Litw. in List Pl. Hb. R. F. VI (1908) 102; Litv. in Tr. Bot. Mus. AN, III, 113; Medv. Der. i Kust. Kavk. 12; Grossh. Fl. Kavk. III, 75.—*T. Pallasii* var. *macrostemon* Bge. et var. *pycnostachys* Bge. Tentam. Gen. Tamar. spec. (1852) 50.—*T. Pallasii* auct. et *T. Pallasii* var. *lagodechiana* Rgl. et Mlokoss. et var. *laxiuscula* Rgl. et Mlokoss. et var. *caspica* Rgl. et Mlokoss. et var. *daghestanica* Rgl. et Mlokoss. et var. *longifolia* Rgl. et Mlokoss. et var. *kumensis* Rgl. et Mlokoss. in Mat. Fl. Kavk. III, fasc. 9 (1909) 88, 90–98.—*T. paniculata* Stev. in DC. Prodr. III (1828) 26, nom. nudum; Schmalh. Fl. I, 169; Maevski Fl. ed. 5, 212.—*T. gallica* var. *vulgaris* Ldb. M. B. Fl. taur.-cauc. 1 (1808) 246, non L.; Ldb. Fl. Ross. II, 1, (1844–1848) 135.—*T. gallica* var. *vulgaris* Ldb. et var. *pycnostachys* Lbd. Fl. Ross. II, 1 (1844–1848) 135.—*T. gallica* var. *Pallasii* Hook., Fl. Brit. Ind. I (1874) 248.—*T. odessana* Stev. ex. Bge. Tentam. Ge. Tamar. spec. (1852) 48.—Ic.: Ldb. Ic. Fl. Ross. 1. c. tab. 256; Bot. Mag. CXXXIII, tab. 8138; C. K. Schn. Laubholzk. II, 342; Fl. S.E. fig. 488; Rusan. 1. c. fig. 20, 16.—Exs. Hb. R. F. no. 1316, 1870; H. F. A. M. no. 314.—

Shrub or small tree 1–3 m. tall, with reddish bark; leaves ovate or deltoid-cordate, 2–5 mm. long, 1–2 mm. wide, acute, nearly amplexicaule. Racemes 3–5 cm. long, 3–5 mm. thick, or elongate, 6–8 cm. long [var. *odessana* (Bge.) Schm.], or contracted, 0.5–1.5 cm. long, 3–4 mm. thick (var. *brachystachys* Bge.), on peduncles 0.2–1 cm. long, in terminal, open or more or less dense panicles; bracts ovate-oblong or lanceo- [312] late, 1.5–2 mm. long, acute, or more or less elongate, linear-subulate (var. *odessana* (Bge.) Schm.), 1.5–2.8 mm. long, exceeding the calyxes (including pedicels); pedicels 0.5–0.7 mm. long, shorter than the calyxes; flowers 5-merous; calyx 0.7–1 mm. long, its lobes ovate, 0.5–0.7 mm. long, 0.3–0.5 mm. wide, more or less acuminate, with narrowly scarious margins; petals obovate, rosy, red, violet, or white (var. *albiflora* Gorschk.), 1–1.5 mm. long, 0.7–1 mm. wide, longer than the calyx by 1/3, slightly emarginate, deflexed, more or less persistent; stamens 5; disk

5-lobed, with emarginate lobes, the filaments filiform, equalling or exceeding the corolla mostly by 1½ times, attached between the lobes of the disk; anthers obtuse; styles 3, clavate, mostly 3–5 times shorter than the ovary, deflexed; capsule triangular-pyramidal, 3–4 mm. long, 0.7–1 mm. wide (at base), 3–4 times longer than the calyx. V–IX. Pl. XVI, fig. 4.

Sandy or clayey solonets steppes, calcareous mountains, solonets, solonchak, banks of streams, lakes, and seas; sandhills. Planted in gardens and parks. EUROP. SECT.: Bessarabia (Baltski region near the Pereimy section), Cis-Chern. (shore of Tingul'sk Bay), Lower Don, Lower Volga. CAUSASUS: Cis-Cauc., Dag., E. & S. Trans-Cauc., Tal. CENTR. ASIA: Aralo-Casp., Cis-Balkh., Kyz.-Kum., Kara-Kum., Gorn. Turkm., Syr-Darya, Pam.-Al., Tian-Shan. GEN. DISTRIB.: Balkans-Asia Minor, Iran, Mongolia, Japan-China (China), Tibet. Described from the shores of Nor-zaisan Sea. Type in Leningrad.

Note. Occurs as a weed in new fallow land, irrigated fields of wheat, barley, and alfalfa, and on margins of irrigation channels.

18. **T. arceuthoides** Bge. in Mem. Acad. Sci. Petersb. VII (1854) 225; Boiss. Fl. Or. I, 775; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 80, 95; Rusan. Centr.-As. Tamar. 67.—*T. montana* Kom. in Tr. SPb. Obshch. estestv. [?St. Petersburg Natural History Society] XXVI (1896) 142.—*T. Pallasii* var. *tigrensis* Franchet, Pl. Turkest. (1883) 70, non Bge.—*T. turkestanica* Litw. in Tr. Bot. Mus. AN, VII (1910) 72.—*T. turkestanica* f. *brachystachys* Litw. ex Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 93.—Ic.: Rusan. 1. c. fig. 22, 10.—Exs.: Hb. F. SSSR no. 3041.

Shrub or tree 2–3 m. tall with reddish, brown-purple or sometimes gray bark and with drooping, partly crowded branches; leaves ovate or nearly deltoid, 1–2 mm. long, 0.5 mm. wide, acute, decurrent at base. Racemes nearly sessile, erect or partly spreading, more or less dense, 3–6(9) cm. long, 2.5–3.5 mm. thick, in simple or sometimes more or less dense, compound panicles; bracts ovate-subulate or lanceolate-subulate, 1–1.5 mm. long, shorter than, nearly equalling, or exceeding the calyxes (including pedicels); pedicels 0.5–0.7 mm. long; flowers 5-merous; calyx 0.5–0.7 mm. long, nearly twice shorter than the petals, with ovate or oblong-ovate, obtuse lobes 0.4–0.5 mm. long, 0.3 mm. wide, mostly colored red or [313] reddish lilac, broadly scarious-margined; petals rosy or violet, obovate or elliptic, 1–1.7 mm. long, 0.5 mm. wide, erect or more or less spreading, deciduous; stamens 5; disk mostly purple, deeply 5-lobed, lobes sometimes emarginate and then disk nearly 10-lobed or 10-angled; filaments slender, long, nearly twice exceeding the corolla, attached between the lobes or angles of the disk; anthers obtuse or sometimes acute; pistil with elongate pointed ovary 0.7–1.3 mm. long and 3 short styles 5–7 times shorter than the ovary; capsule narrow, long, 3 mm. long, 0.7 mm. wide, nearly 4–6 times longer than the calyx. VI–VIII.

Banks and valleys of mountain rivers and creeks, at the edge of the maple zone and lower parts of the juniper zone (to 3600 m.). CENTR. ASIA: Cis-Balkh., Dzh.-Tarb., Gorn. Turkm., Syr-Darya, Pam.-Al., Tian-Shan. GEN. DISTRIB.: Dzh.-Kashg., Mongolia. Described from the mountain Karatau near the city Samrakand, banks of the River Zeravshan. Type in Leningrad.

19. **T. karakalensis** Freyn et Sint. in Bull. Herb. Boiss. 2 ser. III (1903) 1060; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSR, VII, 4, 81, 95.—*T. karakalensis* var. *scoparia* Freyn et Sint. et var. *verrucifera* Freyn et Sint. 1. c. 1062.—*T. florida* Rusan. in the book Plants and Environment (1940) 277, p. p. non Bge.

Shrub up to 2–3 m. tall, with brown or cinnamon-ashy bark, sometimes covered with white warts; leaves cordate or broadly ovate, 0.5–1.5 mm. long, 0.3–0.5 mm.

wide, acutely subamplexicaule, with decurrent base. Racemes 2–3 cm. long, 3–3.5 mm. thick, or longer and more slender, up to 5 cm. long, 2–3 mm. thick (var. *myriantha* Freyn & Sint.), erect or slightly spreading, crowded or more or less scattered, on short peduncles 1–3 mm. long, in more or less compound panicles; bracts lanceolate, 0.7–1 mm. long, acute, equalling or shorter than the calyxes (including pedicels); pedicels 0.3 mm. long, nearly twice shorter than the calyxes; flowers 5-merous; calyx 0.7 mm. long, with ovate, obtuse, broadly scarious-margined lobes 0.5 mm. long, 0.3 mm. wide; petals rosy, oblong, 1 mm. long, 0.5 mm. wide, 1/3 longer than the calyx, deciduous; stamens 5; disk 5-lobed; filaments slender, equalling or slightly exceeding the corolla, attached between the lobes of the disk; styles 3, obovate, mostly 4 times shorter than the ovary. VI–VII.

Banks of rivers and lakes. CENTR. ASIA: Kara-Kum., Gorn.-Turkm. Endemic. Described from Karakala. Type in Leningrad.

Note. F. N. Rusanov states that on account of the aestival flowering *T. florida* was [re-]described under the name *T. karakalensis* Freyn et Sint. While some tamarisks, flowering in spring, not rarely produce new flowers in summer, and, vice versa, summer-flowering kinds sometimes happen to be vernal, this is not a basis for uniting the species, the more so because *T. karakalensis* is well distinguished [314] by mostly shorter terminal flowering racemes and compound panicles, smaller flowers, and 5-lobed disk.

Subgenus 2. **Trichaurus** (Arn.) Gorschk. in Bot. Mat. Herb. Inst. Bot. Inst. AN SSSR, VII, 4 (1938) 78, 96.—*Trichaurus* Arn. in Wight a. Walker Arnott, Prodr. Fl. Pen. Ind. or. I (1834) 40.—Flowers large, calyx 1–3 mm. long; petals 2.5–5 mm. long; stamens numerous, 10–13(14), mostly unequal, long, alternating with shorter ones; flowering racemes terminal, in simple panicles, rarely lateral; leaves amplexicaule or sheathing.

20. **T. passerinoides** Delile, Fl. Aeg. (1813) 58; DC. Prodr. III, 97; Boiss. Fl. Or. I, 778; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 81, 98; Rusan. Centr.-As. Tamar. 47.—*T. passerinoides divaricata* Ehrenb. in Linnaea, II (1827) 276.—*T. pycnocarpa* DC. Prodr. III (1828) 97.—*T. macrocarpa* Bge., Tentam. Gen. Tamar. spec. (1852) 79; Boiss. Fl. Or. I, 779.—*T. mirabilis* Eug. Kor. (in herb. 1916) nom. nudum.—*Trichaurus Aucherianus* Dcne. et *T. pycnocarpus* Dcne. in Jacq. Voy. de l'Inde, IV (1844) 58, 59.—Ic.: Rusan. l. c. fig. 20, 15.

Shrub with purple, violet-brown or gray-brown bark, up to 1–2 m. tall; leaves broadly deltoid or broadly cordate, 0.3–2 mm. long, 0.7–2 mm. wide, acute, amplexicaule. Racemes 2–6 cm. long, 0.7–1 cm. thick, nearly spicate or scattered (var. *macrocarpa* Ehrenb.), on peduncles 1–2 cm. long, in simple open panicles; bracts ovate-deltoid, 1–1.5 mm. long, equalling or shorter than the pedicels; flowers large, 5-merous; calyx 1.5–2.5 mm. long, with broadly ovate, more or less acute, broadly scarious-margined lobes 1–2 mm. long, 1–1.7 mm. wide; petals rosy, ovate-elliptic or ovate-oblong, 3–4 mm. long, 1.5–2.5 mm. wide, 2–3 times longer than the calyx, deciduous or persistent (var. *macrocarpa* Ehrenb.); stamens 10–12(14); disk thick, deeply 10–12(14)-lobed, exceeding the widened bases of the filaments, these often unequal, elongate ones alternating with somewhat shortened ones; anthers more or less short-apiculate; pistil with bottle-shaped or ovoid-pyramidal ovary and 3–4 mostly obovate, deflexed styles 2–3 times shorter than the ovary; capsule 6–8 mm. long, 3 mm. broad, or larger, 0.8–1.2 cm. long, 3–5 mm. broad (var. *macrocarpa* Ehrenb.). III–V.

On banks of rivers and seas, in solonchak or coastal sands. CENTR. ASIA: Kara-Kum., Gorn.-Turkm. GEN. DISTRIB.: Mediterranean (E.), Balkans-Asia Minor (E. part), Iran, N.E. Africa (N. Egypt). Described from Egypt. Type in Paris?

21. **T. kasakhorum** Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4 (1938) 91.

[315] Shrub up to 3 m. tall, bark brown or gray-brown; leaves ovate-lanceolate or oblong-lanceolate, 1–2 mm. long, 0.5 mm. wide, acute, nearly semiamplexicaule, decurrent at base. Racemes elongate, slender, 4–10(13) cm. long, 3–4 mm. thick, in mostly dense panicles; bracts lanceolate-subulate, 1–1.5 mm. long, equalling the pedicels or exceeding them; pedicels 1 mm. long, equalling the calyxes; flowers 5-merous; calyx 1 mm. long, 1/3 shorter than the petals, its lobes ovate, 0.5 mm. long, 0.4 mm. wide, acute, scarious-margined; petals rosy, oblong, 1.5 mm. long, 0.5 mm. wide, obtuse, persistent; stamens 5; disk 5-lobed; filaments slender, ¼ or 1½ times exceeding the corolla, attached to the lobes of the disk; anthers obtuse; styles 3, short, 4–5 times shorter than the ovary. VI.

Sandy and solonets steppes, banks of rivers and lakes. CENTR. ASIA: Aralo-Casp. Endemic. Described from Kazakhstan, Kzyl-ordinsk district near the land of Saarsara. Type in Leningrad.

Hybrid *T. leptostachys* Bge. × *T. ramosissima* Ldb. (Rusan. Centr. As. Tamar. 60, 61.)

22. **T. Karelinii** Bge. Tentam. Gen. Tamar. spec. (1852) 68; Boiss. Fl. Or. I, 776; Pavl. Fl. Centr. Kazakhst. II, 446, 470; Gorschk. in Weedy Pl. SSSR, III, 301; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 80, 92.—*T. Pallasii* cum var. *T. ramosissima* Ldb. ex Karel. in Bull. Soc. Nat. Mosc. (1939) 154.

Shrub with purple-brown bark and slightly drooping branches; leaves short-ovate, 1–1.5 mm. long, 0.5–1 mm. wide, acute, nearly amplexicaule, at base obtusely short-decurrent. Racemes terminal, elongate, slender, 5–15 cm. long, 2–4 mm. thick, with peduncles 0.5–3.5 cm. long, in open panicles; bracts lanceolate, 1.7–2 mm. long, acute, equalling or exceeding the calyxes (including pedicels), with more or less widened base; pedicels 0.5–0.7 mm. long; flowers 5-merous, nearly sessile; calyx 1 mm. long, 1/3 or less shorter than the petals, with nearly orbicular, obtuse, scarious-margined lobes 0.5–0.7 mm. long, 0.5 mm. wide, often tinged with rosy violet color on the lobes; petals oblong-elliptic, rosy or violet, 1.3–1.5 mm. long, 0.7 mm. wide, obtuse, deflexed or erect, semi-deciduous; stamens 5; disk thin, 5-angled, exceeding the widened filament-bases; filaments nearly equalling the corolla; anthers short-apiculate; styles 3, oblong-clavate, 4–5 times shorter than the ovary; capsule 5–6 mm. long, 1–3 mm. wide, 5–6 times exceeding the calyx. V–IX. Pl. XVI, fig. 1.

Banks of seas, rivers, saline lakes, margins of sand hills, solonets and clayey deserts. CENTR. ASIA: Cis-Balkh. (Ak-su, Lake Alakul'), Kyz.-Kum., Kara-Kum., Gorn. Turkm. GEN. DISTRIB.: Iran (province Khorasan), Mongolia. Described from the island of Ogurchinsk (Caspian Sea). Type in Leningrad.

[316] Hybrid *T. ramosissima* Ldb. × *T. hispida* Willd. (Rusan. in book Plants and Environment (1940) 277.)

23. **T. Ewersmannii** Presl ex Bge. Tentam. Gen. Tamar. spec. (1852) 48; Gorschk. in Fl. S.E. V, 720; Pavl. Fl. Centr. Kazakhst. II, 465, 469; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 80, 95; Gorschk. in Maevski Fl. ed. 7, 514.—*T. gallica* var. *micrantha* Ldb. Fl. Ross. II, 1 (1844-1846) 135, ex p.—Exs.: Hb. R. F. no. 1960.

Shrub with red-brown bark, 2–3 m. tall; leaves ovate-lanceolate or ovate-oblong, 1.5–4 mm. long, 0.5–1 mm. wide, acute, with rounded base, decurrent, often broken off toward tip. Racemes 1–3.5(4) cm. long, 2–3 mm. thick, simple, in sweeping

interrupted panicles; bracts nearly linear-subulate, acute, 1.5 mm. long, scarious-margined, longer than the pedicels, which are 0.5–0.7 mm. long, shorter than the calyxes; flowers 5-merous; calyx 1 mm. long, with triangular-ovate, acute, scarious-margined lobes 0.5–0.7 mm. long; petals rosy, oblong, 1.8–2 mm. long, 0.7–1 mm. wide, twice longer than the calyx, obtuse or slightly emarginate, spreading, persistent; disk deeply 5-lobed, the lobes mostly deeply emarginate; stamens 5; filaments slender, long, 1½–2 times longer than the corolla, attached between the lobes of the disk; anthers acute; styles 3(4), obovoid, deflexed, 2 times shorter than the ovary. V–VIII.

Clayey, arid steppes, banks of streams and alkaline lakes. EUROP. SECT.: Lower Volga. CAUCASUS: Cis-Cauc. CENTR. ASIA: Aralo-Casp., Cis-Balkh. Endemic. Described from the mouth of the Volga. Type in Leningrad.

Hybrid *T. ramosissima* × *T. leptostachys* Bge. (Rusan. in book Plants and Environment (1940) 277.)

24. **T. Korolkovii** Rgl. et Schmalh. in Tr. Bot. Gard. V (1877) 582; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 80, 95.—*T. leptostachys* Rus. Centr.-As. Tamar. (1949) 58, 59, non Bge. p. p.

Shrub with reddish brown bark; branches more or less appressed; leaves ovate or oblong-ovate, 1–1.5 mm. long, 0.5 mm. wide, acuminate, nearly amplexicaule, with decurrent bases. Racemes long, slender, up to 15 cm. long, 3–4 mm. thick, on peduncles 0.5–2 cm. long, in dense, more or less compound panicles; bracts lanceolate, acuminate, 1 mm. long, nearly equalling or shorter than the pedicels, which are 1 mm. long, shorter than the calyxes; flowers 5-merous; calyx 0.7 mm. long, its lobes triangular-ovate, 0.5 mm. long, 0.4 mm. wide, acute, scarious-margined; petals rosy, ovate or ovate-oblong, 1–1.3 mm. long, 0.7 mm. wide, ⅓ [317] or sometimes nearly twice longer than the calyxes, erect, obtuse, deciduous; stamens 5; disk 5-lobed, lobes with small emarginations; filaments slender, nearly equalling the corolla, attached between the lobes of the disk; anthers obtuse; styles 3, 4 times shorter than the ovary. V–VI.

Valleys and banks of rivers. CENTR. ASIA: Cis-Balkh. (Lake Alakul', land of Baigakum), Kyz.-Kum. (between Amu-Darya and Khivoi, Khazar-ama), Kara-Kum. (Farab), Gorn. Turkm. (Aidin, Germab). GEN. DISTRIB.: Dzh.-Kashg. (Kashgaria). Described from the mountain Khazar-ama between Amu-Darya and Khivoi. Type in Leningrad.

Hybrid *T. ramosissima* Ldb. × *T. leptostachys* Bge. (Rusan. in book Plants and Environment (1940) 277.)

Note. In his last publication F. N. Rusanov (Centr.-As. Tamar. 1. c.) considers that *T. Korolkovii* is one of the forms of *T. leptostachys* Bge., as to which I offer the following remarks. *T. Korolkovii* is well distinguished by lanceolate bracts, nearly equalling or shorter than the pedicels, erect petals, 5-lobed disk with lobes slightly emarginate, and slender staminal filaments, nearly equalling the corolla, attached between the lobes of the disk.

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[318] EXPLANATION OF PLATE XVI.

1. Tamarix Karelinii Bge., part of infl., disk.—2. T. hispida Willd., part of infl., disk.—3. Myricaria alopecuroides Schrank, infl., detail of same, stamens, seed.—4. T. ramosissima Ldb., part of infl., disk, seed.—5. T. leptostachys Bge., infl., detail of same, disk.

Таблица XVI

25. **T. Komarovii** Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4 (1938) 96.—Ic.: Gorschk. 1. c. 97 fig. 6.

Shrub with brown bark; leaves ovate or oblong-ovate, 1–2 mm. long, 0.5–1 mm. wide, acute, semi-amplexicaule. Racemes terminal, simple, more or less slender, (1.5) 3–6 cm. long, 4–6 mm. thick, on peduncles 1–2 mm. long, in sweeping panicles; bracts lanceolate, 1.7–2 mm. long, acute, scarious-margined, shorter than or equalling the calyxes (including pedicels); pedicels 0.5–0.7 mm. long, 2–3 times shorter than the calyxes; flowers 5-merous; calyx 1.5 mm. long, with ovate, acute, scarious-margined lobes 1 mm. long, 1 mm. wide; petals oblong-elliptic, rosy, 2.5 mm. long, 1–1.5 mm. wide, ⅓ longer than the calyx, obtuse, deflexed; stamens 10; disk nearly 5-lobed, filaments slender, unequal, longer alternating with shorter, attached to the lobes of the disk and between them; anthers obtuse; pistil with oblong-ovoid ovary 2.5–3 mm. long, and 3 short styles, 4 times shorter than the ovary. VI-VIII.

Sands, solonchak. CENTR. ASIA: Kara-Kum., (Aidin, Dzhebel, Akhchakuima). Endemic. Described from the area of Aidin. Type in Leningrad.

Hybrid *T. passerinoides* × *T. ramosissima* Ldb. (Rusan. Centr.-As. Tamar. 50).

DOUBTFUL SPECIES

1. **T. affinis** Bge. Tentam. Gen. Tamar. spec. (1852) 36; Pavl. Fl. Centr. Kazakhst. II, 464; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 78, 81.—*T. laxa* Bge. in Mem. Acad. Sc. Petersb. VII (1851) 291 [318] non Willd.—*T. gracilis* Rusan. Centr.-As. tamar. (1949) 5, p. p. non Bge.

Shrub with pale, yellowish-cinnamon bark; leaves cordate-ovate, 1.3–2.5 mm. long, 0.5–1.3 mm. wide, acute, with more or less widened base, decurrent, nearly amplexicaule. Racemes lateral, interrupted, slightly spreading or nearly ½ drooping, almost sessile, with oblong scales at base; bracts oblong or cordate-ovate, concave, equalling or slightly shorter than the pedicels, which are slightly longer than the calyxes, slightly divaricate or half reflexed; flowers 4–5-merous; calyx with ovate, nearly orbicular lobes, broadly scarious-margined, subserrulate; petals obovate, nearly twice longer than the calyx, with cuneate base, deciduous, spreading; stamens 4–5; disk 8–10-angled, exceeding the slender or slightly widened filament bases; anthers purple, cordiform, short-apiculate; styles 3–4, nearly clavate. IV.

CENTR. ASIA: Aralo-Casp. Described from shores of the Aral Sea, Barsuki, Yamart-kul'. Type in Leningrad.

Note. Doubtful species, owing to the fragmentary type, as represented in the herbarium. F. N. Rusanov in 1940 (in book Plants and Environment, 277) maintained that "while positive determination is lacking, *T. affinis* Bge. is a hybrid between *T. gracilis* Willd. and *T. Litwinowii* Gorschk." This he however in 1949 (Centr.-As. Tamar. 51) now treats as a synonym of *T. gracilis* Willd.; from the latter *T. affinis* Bge. is distinguished by lateral flowering racemes and oblong or cordate bracts equalling or shorter than the pedicels.

2. **T. aralensis** Bge. Tentam. Gen. Tamar. spec. (1852) 59; Gorschk. in Bot. Mat. Herb. Bot. Inst. AN SSSR, VII, 4, 80, 95.—*T. gracilis* Willd. × *T. hispida* Willd.; Rusan. in book Plants and Environment (1940) 277.

Shrub with brownish, chestnut or reddish bark; leaves cordate-ovate or cordate-lanceolate, acute, 1.5 mm. long, 0.7 mm. wide, with short-decurrent base. Racemes on short peduncles in sweeping panicles; bracts lanceolate, acute; calyx with 5 acute lobes; petals 5, ovate, deciduous; stamens 5; disk 5-lobed, the lobes indented; filaments filiform, attached between the lobes of the disk.

[321[6]] On sea shores.—CENTR. ASIA: Aralo-Casp. (north shore of the Aral Sea). Endemic. Described from the stated locality. Type in Paris.

NOTE. Ambiguous species, its type remaining unknown to us. The report [of it] as a hybrid between *T. gracilis* Willd. and *T. hispida* Willd. seems to us incorrect.

3. **T. altaica** Niedenzu in E. u. P. Pflanzenfam. ed. 2, XXI (1925) 287.

Owing to lack of diagnosis and absence of type, it is not possible to form an exact opinion about this plant.

APPENDIX: NOTES ON TAMARIX IN THE SOUTHWESTERN UNITED STATES

Because its representatives with us are cultivated or are common weeds, they are of course habitually ignored by collectors. There is consequently no adequate material on which to base an account of what we have. Matters are made much worse by the lack of adequate Old World material in American herbariums for comparison, and the absence of any recent comprehensive monographic account of the genus. The following key and notes, based mainly on 87 specimens in the S.M.U. Herbarium (most from Texas, some from other Southwestern states and from cultivation, a few from Europe) are exceedingly preliminary, and are offered chiefly to call attention to the taxonomic complexities of the genus even as found with us.

1a. Scale leaves with sheathing bases encircling the branchlets, the blades reduced to small sharp points much smaller than the sheathing bases ..... 1. *T. aphylla*

1b. Scale leaves with clasping bases extending half way around the branchlets or less, the blades slightly smaller to larger than the bases

2a. Racemes borne on old wood, lateral, one or few at a node, simple

3a. Racemes produced before and with new green shoots in spring; cultivated

4a. Sepals, petals, and stamens each 4 ..... 2. *T. parviflora*

4b. Sepals, petals, and stamens each 5 ..... 3. *T. africana*

3b. Racemes produced with or mostly after new green shoots; wild on Texas Gulf Coast (but presumably escaped from cultivation) ..... 4. *T. speciosa (?)*

2b. Racemes borne on growth of the current year, mostly or all terminal, solitary or several or in panicles

5a. Anthers (viewed from back, before pollen is shed) 1½–2 times as long as wide, with a prominent beak or short spine at upper end

[6] Page 319 is occupied by Plate XVI, p. 320 is blank. (Translator's note.)

6a. Racemes simple, 1.0–3.5 cm. long, borne in elongating terminal spikes ..... 5. *T. gallica* var. (?)

6b. Racemes borne in a much-branched panicle ..... 6. *T. gallica* var. (?)

5b. Anthers (viewed from back, before pollen is shed) slightly or not longer than wide, with an indistinct small point or none

7a. Styles separate, 0.3–0.5 mm. long, abruptly widened to a broad tip; petals falling as fruit forms (sometimes tardily) ..... 7. *T. gallica* var. (?)

7b. Styles united at base, 0.5–1.0 mm. long, gradually enlarged to apex; petals persistent in fruit ..... 8. *T. gallica* var. (?)

1. T. APHYLLA (L.) Karst. Foliage blue-green; flowers dull white or faintly pink-tinged. This is by far the most commonly planted species in southern Texas (Austin southward), but is not much inclined to run wild, although self-sown plants are established at Galveston, on the coast. Specimens also seen from Arizona. Flowers freely in southern Texas, but according to Zohary it seldom does so in Israel, though presumably native there.

2. T. PARVIFLORA DC. Occasionally planted along highways in eastern Texas, flowering early in the spring. Dr. McClintock does not believe this is distinct from the earlier-described *T. tetrandra* Pallas.

3. T. AFRICANA Poir. Dr. McClintock mentions having seen a specimen of this from Texas. It is not known to me except from two European specimens. Racemes much thicker than in no. 2.

4. T. SPECIOSA Ball emend. Maire. Several collections from the Texas Gulf Coast. Bracts in basal portion of racemes (under lowest flowers or just below flowering portion) oblong-lanceolate, rather short-acute, with tip of different color and texture from the body; in the members of the *gallica* complex they are broader at base, acuminate, with tip of similar texture to body. Said to be very variable in North Africa. No authentic specimens have been examined; determination based on the sketchy key of Jahandiez & Maire, and the brief original description.

5. T. GALLICA L. var. (?). This is the most distinctive of the *gallica* forms; possibly it is actually var. *gallica*. Known from the Texas Gulf Coast and Cotton Co., Oklahoma. The first naturalized kind, collected in 1876 on Galveston Island.

6. T. GALLICA L. var. (?). Very similar in general appearance to nos. 7 and 8. Petals light lavender-pink. Anthers less strongly apiculate than in no. 5. This also could be var. *gallica*. Known only from planted specimens at Ballinger, Runnels Co., Texas.

7. T. GALLICA var. (?). This is the type most often passing as true

gallica, when *T. pentandra* is distinguished. Flower color variable, but usually pale. Widespread in Texas and Oklahoma.

8. T. GALLICA L. var. (?). "*T. pentandra* Pallas" of American authors. Flowers usually (but not always) deeply colored. The commonest naturalized species throughout the Southwest, and for much of the region also the most often cultivated. Dr. McClintock suspects that *T. chinensis* may be the same. It should be *T. ramosissima* of Gorschkova's treatment (no. 17). Often passing in the U.S. as *T. gallica*.

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ANATOMY AND LIFE CYCLE OF THE SNAIL RUMINA DECOLLATA (PULMONATA: ACHATINIDAE)

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ABSTRACT. The anatomy of the gastropod *Rumina decollata* (native of the Mediterranean region, introduced in the southeastern U.S.) is described from gross dissection of organ systems. Reproduction is traced through copulation, egg-laying, and rapid direct development to maturity. At Abilene, Texas, the animal was found to be active following late summer rains and intermittently through the winter (burrowing in very cold weather), going into estivation for the dry summer season.

Rumina decollata L. is a terrestrial snail with a coiled shell, belonging to the Order Pulmonata, Family Achatinidae. The species name refers to the broken apex of the shell, a decollated shell. Native of the Mediterranean region, the animal is now widely distributed in the southeastern and south central portions of the United States. Although it is a rather common garden pest in the states on the northwestern side of the Gulf of Mexico, little descriptive literature concerning this species has been published.

DISTRIBUTION AND OCCURRENCE

Rumina decollata is indigenous to the Mediterranean region and was introduced into the United States early in the 19th Century at Charleston, South Carolina. Pilsbry (1905) summarized the distribution of this species as follows: entire Mediterranean region, the typical forms from southern France, Italy, Sicily, and the Canary Islands; introduced in the Azores, Madeira, and Cape Verde Islands, Bermuda, Santo Domingo, Cuba, and Charleston, South Carolina. Cheatum (1934) reviewed the distribution of the species in the New World, citing various collections and published reports: "For the past three years, this species has been thriving in several backyards in Oak Cliff, a suburb of Dallas. . . . On a recent trip . . . found in abundance along the banks of the Guadalupe River, one-half mile southwest of Greene[2] . . . In Breckenridge Park, San Antonio, this species is distributed all along the banks of the San Antonio River . . . Johnson (. . . 1900) speaks of a colony that lived for a while in Philadelphia . . . Smith

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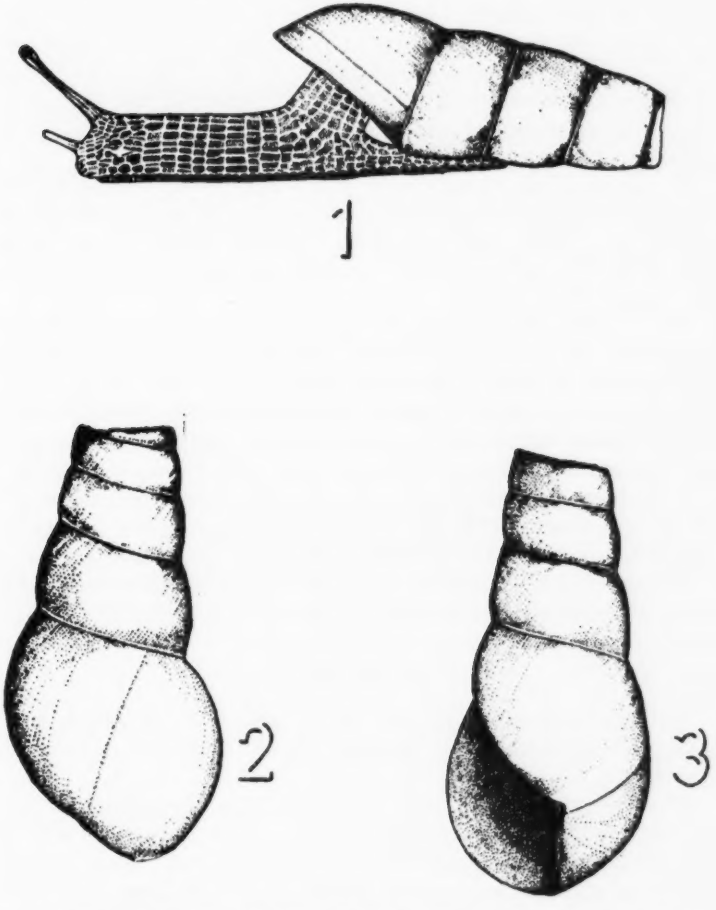
[2] Misspelling of Gruene, near New Braunfels, Comal County. (Information supplied by Dr. S. W. Geiser.)

(. . . 1912) notes the shells as common in cemeteries of New Orleans, La., and the older parts of Mobile, Ala. Ferriss (. . . 1914) calls attention to its being found by Camp in Brownsville, Texas. Recently *Rumina* has been collected in the south part of Houston, Texas. . . . It seems quite probable that this species occurs over a much wider area in the southern United States than hitherto reported." Large numbers have been found in gardens in San Angelo, Texas, and it was collected by the writer in Abilene.



***Rumina decollata*. Fig. 1, fully extended; Fig. 2, ventral view; Fig. 3, dorsal view.**

METHOD OF STUDY

The snails for this study were collected in the southwestern part of the City of Abilene, Texas. Numerous snails were observed actively crawling about following a late summer rain. The collection was made in August, 1950, at which time specimens of all sizes were taken.

Culturing *Rumina decollata* was not at all difficult, and it was found that the species would live and breed with little attention. Specimens of all sizes were kept in a glass terrarium with three to four inches of soil which was kept damp. This container was kept in a room where the temperature remained fairly constant at 20° C. The snails would eat a wide variety of organic matter, both plant and animal material. They were fed commercial preparations of fish food, cereals, dried shrimp, and various green vegetables, but preferred and thrived on lettuce leaves and rolled oats. The snails would drink water from low containers placed in the terrarium.

Activities of the animals were easily observed through the glass walls without disturbing them. Certain individuals were separated and kept in individual containers for the collection of specific data on the life cycle. The death rate of the original collection was four per cent for a period of ten months.

The anatomical studies were made using both freshly killed and preserved specimens. These terrestrial pulmonates were best killed by asphyxiation in stoppered bottles entirely filled with water. After about twenty-four hours, when all the dissolved oxygen had been used up, the snails were found to be insensitive and extended. The preserving fluid used was five per cent formalin or seventy per cent ethyl alcohol. Freshly killed specimens were excellent for the initial identification of organs, but the preserving solution served as a hardening agent of the tissue to allow for a more intensive examination.

Dissection was done with the aid of a wide-field binocular microscope. No histological studies were made.

GENERAL HABITS

Rumina decollata will thrive in many soil types in the South. It appears that temperature and moisture are the limiting factors in distribution.

The colony at Abilene, Texas, was found in a heavy loam soil containing much clay, but the snails grew equally well when transferred to a sandy soil. The colony was associated with the arthropod, *Armadillidium vulgare*, the common sowbug or pillbug. Some specimens were found extended and crawling about; others were entirely covered

by humus or had only the apices of their shells visible. Both living and dead shells were found. While most of the snails burrow in the soil during a dry period, some remain on the surface and only withdraw into the shell. The snails are very active after a rainy period, but will not become extended while rain is falling due to the sensitivity of the tentacles which are withdrawn immediately upon contact.

Rumina decollata is active intermittently throughout the winter in the South. A rainy period followed by a few warm days results in their appearance at the surface of the ground. A few cold days, however, will cause them to burrow into the soil, sometimes far enough down to cover their shells completely.

The snails have an aversion to light and usually remain hidden by day and feed mainly at night or after rain. Observation of laboratory specimens was most rewarding at night.

In their natural habitat the snails feed upon living vegetable matter, from which fragments are torn and swallowed by means of the radula, a tongue-like structure. During feeding, the snail can pass this organ against the roof of its mouth, or can advance it to the jaw, or can even project part of it beyond the jaw. The radula does not bite the food taken into the mouth and thus mince it, but rasps it to pieces.

DESCRIPTION

SHELL.—*Rumina decollata* is a univalve (Plate I) having the shell spirally coiled to the right, the whorls built around a hollow central columella. The shell is turriculated, longitudinally striated with irregular elevated lines or wrinkles, which are a litte more prominent near the sutures. Coils are tightly fused together at the sutures, and the sutures are not deeply indented. The whorls ordinarily are four; occasionally five are found. The variation occurs due to the habit of decollation. Young snails develop seven distinct whorls before decollation, which begins in the fifth whorl. A portion of the fifth whorl remains, giving a broken appearance. It was observed that the snails would, on occasion, aid in the decollation by striking the shell against rocks or the glass wall of the terrarium. No snails of this collection reached an adult size without decollation; however, Ferriss (3) reports that Mr. Camp found a large colony in a Brownsville, Texas, garden and succeeded in getting a few specimens without losing the points, carrying them in cotton.

The maximum size reached by snails in the collection was 29 mm. in length and 11 mm. in diameter. The body whorl is more than double the width of the truncated apex, the spire almost three times the length of the aperture. The large anterior opening faces to the right.

In the truncated form of the apex of the spire, this species resembles *Pupa torticollis* and *Bulimus multilatus*. It is sufficiently distinct from the latter, to which it is more closely related than to the other, by its more cylindrical and less conical form, being less robust and more elongated; the aperture is narrower and forms a smaller proportion of the total length. The shell of *Rumina decollata* turns an opaque white after the death of the animal.

EPIPHRAGMA.—During hibernation the shell aperture is closed leaving only a small hole for breathing. The head and foot are withdrawn into the shell and the edges of the mantle approximate to form an almost complete disc filling up the aperture. A membrane (epiphragma) is secreted by the edge of the mantle. The epiphragma is essentially a layer of dried slime, supplemented and strengthened by the addition of calcium phosphate. It hermetically seals, during estivation, and prevents the loss of moisture. The epiphragma is dropped when the animal resumes an active existence at the beginning of a moist season.

GENERAL BODY ANATOMY.—The body of the snail is composed of three regions, the visceral hump, the head, and the foot. The visceral hump is the portion of the body covered by the shell when the animal is extended; the head and foot make up the portion outside the shell. The elongated foot is blunt anteriorly and pointed posteriorly, and its pedal gland opens above the front of the foot and below the inferior lip of the head. There is no boundary between the head and the foot, and the whole can be retracted within the shell by the action of the columella muscle.

The two pairs of tentacles on the head are tactile and capable of invagination. The first are short and olfactory in function; the larger posterior pair bear a pair of simple eyes at their tips. Both pairs of tentacles are hollow and when retracted are turned outside-in by contraction of a muscle attached to the inside of the tip. The mouth is a transverse slit just ventral to the anterior pair of tentacles. The reproductive aperture is on the right side of the body below and behind the second pair of tentacles.

The junction of the visceral hump with the rest of the body is seen anteriorly as a thickened collar, which is the edge of the mantle and the seat of the secretion of the principal layers of the shell. The external opening of the mantle cavity and the anal opening are adjacent and lie in the posterior region of the mantle collar. The first turn of the spiral contains the mantle cavity, the kidney, and the heart. The remainder of the coiled visceral hump contains the lobes of the digestive

gland, loops of intestine, albumen gland of the reproductive system, and the ovo-testis.

DIGESTIVE SYSTEM.—The alimentary canal begins with the buccal mass. The ventral mouth has three lips, two lateral and one ventral. On the roof of the mouth is a small transverse bar, the jaw, and in conjunction with this works the radula. The radula lies upon a thick muscular cushion on the floor of the snail's mouth in a ventral diverticulum of the buccal cavity called the radula sac. A tough membrane covers its under surface, and it bears many rows of teeth. The central tooth of the radula is supported by tissue resembling cartilage, which also serves for the attachment of muscles. The whole forms the rounded organ which is the buccal mass.

The esophagus is narrow and passes from the buccal mass through the nerve ring to a thin-walled crop. A pair of salivary glands lies on each side of the crop, and their two ducts pass forward through the nerve ring to open into the top of the buccal mass. The crop is succeeded by the thin-walled stomach, which is wider than the crop and receives the ducts of the digestive glands. The intestine lies within the larger left digestive gland and follows an S-shaped course to the rectum which lies along the inner margin of the mantle cavity.

RESPIRATORY SYSTEM.—The mantle cavity is developed as a lung with a small external opening, the pneumostome. The mantle forms the roof of the lung cavity and is highly vascular. The floor of the cavity is arched and has a layer of muscles. Muscular contraction and relaxation result in the change in size of the cavity, with resultant intake and expulsion of air. Exchange of gases occurs with the blood vessels in the roof of the cavity.

EXCRETORY SYSTEM.—The excretory system is simple, there being one kidney drained by a single kidney duct. The ureter is a thin-walled tube that passes along the edge of the kidney, runs along the right border of the mantle cavity parallel to the rectum, and opens by an elongated slitlike opening in the right edge of the pneumostome above the anus.

CIRCULATORY SYSTEM.—In the mantle cavity lying anterior to the kidney, is the pericardium enclosing the ventricle and single auricle. The muscular ventricle is smaller than the large thin-walled auricle. A single aorta leaves the ventricle and divides into an anterior (cephalic) aorta which supplies the head and foot, and a posterior (visceral) aorta which passes along the ventral surface of the digestive gland to supply the whole visceral hump. From the terminal branches of these arteries the blood enters a system of irregular lacunae, the haemocoele. The haemocoele discharges blood returning to the heart

into the circulus venosus, which empties into afferent vessels. The afferent vessels lie along the sides of the mantle cavity, blood from the head and foot passing into the left arm of the afferent vessel and blood from the visceral hump entering the right arm. The afferent vessels break up into a capillary system in the roof of the mantle cavity, reuniting to form the efferent branchial vessel (pulmonary vein) which returns the blood to the heart. The efferent branchial vessel is the most prominent vessel and lies along the middle of the roof of the mantle cavity. The part of the right arm of the afferent branchial vessel lying alongside the kidney gives rise to afferent renal vessels. An efferent renal vessel joins the efferent branchial vessel immediately before it enters the auricle.

NERVOUS SYSTEM.—The anterior part of the nervous system is enclosed in a nerve ring which encircles the esophagus. The ganglia and nerves forming the ring are enclosed in dense connective tissue. A pair of lobed cerebral ganglia forms the roof of the ring. The ventral part of the nerve ring is made up of the pedal, pleural, and visceral pairs of ganglia. Laterally, the pedal and pleural ganglia are linked on either side to the cerebral ganglia by the cerebro-pedal and cerebro-pleural connectives.

From the cerebral ganglia pass forward a pair of cerebrobuccal connectives leading to the buccal ganglia, two pairs of tegumentary nerves, and a pair of prominent optic nerves which run alongside the retractor muscles of the posterior tentacles.

From the pedal ganglia pass numerous pedal nerves to the nerve net in the foot.

The visceral ganglia give rise to visceral nerves which pass posteriorly. Laterally, arise a pair of pallial (mantle) nerves, and posteriorly the genital nerve and the median mantle nerve.

REPRODUCTIVE SYSTEM.—The reproductive system is hermaphroditic. Eggs and sperm are produced in the ovo-testis which is protandrous, preventing self-fertilization. The ovo-testis is a small gland found in the apex of the visceral hump, lying in the inner surface of the right digestive gland. From the ovo-testis, the convoluted hermaphrodite duct runs to the albumen gland. The albumen gland lies between the left digestive gland and the coiled right digestive gland. From the albumen gland arise two ducts, the larger of which is the female duct (oviduct) and the smaller the male duct (vas deferens). The vas deferens coils slightly toward its junction with the penis. The muscular penis is protrusible through the common genital opening, and is withdrawn again by the retractor muscle attached to its posterior end. The oviduct opens into a short, thick-walled vagina. Both

vagina and penis open into a common genital atrium with the opening to the exterior far forward on the right side. At the junction of the vagina and penis a spermathecal duct begins, lies close to the oviduct, and then diverges and enlarges to form a bulbous spermatheca, for the storage of spermatozoa from another snail.

The anterior part of the reproductive system, including the common genital atrium, the penis, the vagina, and the anterior parts of their ducts, lies in a body cavity which also contains the anterior portion of the alimentary canal and the anterior portion of the nervous system.

REPRODUCTION

Cross-fertilization is the rule in these hermaphroditic snails. There is reciprocal fertilization, that is mutual impregnation, preceded by a preparatory event in which two snails approach each other and evert the genital atrium. Copulation occurs in forty to sixty seconds. Copulation of snails in this collection began in the middle of September and continued for a period of three weeks. After copulation occurred, the snails were isolated and each was found to produce numerous clutches of eggs.

The first eggs were laid in from nine to nineteen days following copulation. This irregularity is due probably to delayed fertilization or retention of the eggs in brood pouches. The average time interval was 13 days. Successive clutches of eggs were then laid at intervals into the early spring. The tendency is for the total number of eggs in a clutch to increase in successive clutches. The number of eggs per clutch varied from 7 to 30. Three typical cases are as follows: snail No. 4, six clutches of eggs totaling 85 eggs, laid between October 8 and November 18; smallest clutch, 7, largest, 24. Snail No. 7, four clutches of eggs, totaling 70 eggs, laid between September 3 and October 29; smallest clutch, 7, largest, 26. Snail No. 8, ten clutches, totaling 143 eggs, laid between October 12 and November 19; smallest clutch, 7, largest, 30.

The eggs measure 2 mm. in diameter. There is some slight variation in this size. The zygote is enveloped in great quantities of albumen and the whole is encased in a calcareous test, not unlike that of birds. The eggs are laid in small holes in the soil.

The usual period of incubation varies from twenty-five to thirty-six days, or an average time of 28.5 days. In one case it was only nine days. This very short incubation time occurred in September, at the onset of egg laying. This variation could occur if the eggs were retained in a brood pouch for further development.

DEVELOPMENT AND GROWTH

The eggs hatch directly into small snails. The spiral shell begins as a capsule, additions being made at the open or mouth end. Development is very rapid. The young snails are active and feeding on the day after hatching. The shell consists of one and one-half whorls 1.75 mm. in length when hatched. In ten days the length has increased to 5.6 mm. with four complete whorls. When twenty days old, there are six whorls with a length of 9 mm. At the end of a month's growth, the snails have reached a length of 12 mm. with seven whorls and decollation in the fifth whorl. After decollation there is increased growth in the anterior whorls and adult size is reached at two and one-half months. At this time they are 12.5 mm. long.

After attaining adult size, snails in this collection went into hibernation for a period of five weeks. Following hibernation the young snails began copulating and produced eggs.

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TEJACHERNES (ARACHNIDA-CHELONETHIDA, CHERNETIDAE-CHERNETINAE), A NEW GENUS OF PSEUDOSCORPION BASED ON DINOCHEIRUS STERCOREUS

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ABSTRACT. *Dinocheirus stercoreus* Turk (1949, Ann. Mag. Nat. Hist. ser. 12, 2: 120–126) is designated type species of the new genus *Tejachernes*, characterized by having 3 setae (rarely a small additional seta as well) in the cheliceral flagellum, by lacking subbasal tactile seta on the cheliceral hand, by the arrangement of tactile setae on the chelal fingers, and by the absence of a tactile seta from the fourth pedal tarsus. A redescription of the species is given, based chiefly on a series of topotypes from Bracken Cave, Comal Co., Texas, plus collections from Frio Cave, Uvalde Co., Texas.

In 1949, Turk published the description of *Dinocheirus stercoreus* from Bracken Cave, Comal Co., Texas. Examination of a series of topotypes received from Dr. R. B. Eads and Mr. J. S. Wiseman, Department of Health of the State of Texas, indicates that Turk's species does not belong in *Dinocheirus* and that a brief supplemental description is advisable.

TEJACHERNES, NEW GENUS

Type species: *Dinocheirus stercoreus* Turk, 1949.

Description: A genus of the subfamily Chernetinae. Body robust, palps typically chernetin in appearance. Carapace with surface strongly granulate, setae multispinulate to moderately clavate; two eyespots; two strongly developed transverse furrows, the posterior furrow much closer to the posterior carapacal margin than to the median furrow. Abdomen with surface of tergites coarsely granulate; marginal setae of tergites moderately clavate; eleventh sternite with a pair of sublateral acuminate tactile setae, no acuminate tactile setae on eleventh tergite. Chelicera with three setae in flagellum (rarely a small additional seta present); galea with several rami along the distal one-half; cheliceral hand with the subbasal tactile seta wanting, the basal tactile seta broadened and terminally and subterminally paucispinulate. Palps with investing setae multispinulate to weakly clavate; movable chelal finger with tactile seta *st* separated from *t* by no more than the width of the finger at the level of *t*, *sb* and *b* separated by no

more than four areolar diameters, the distance between *st* and *sb* at least three times the distance between *st* and *t;* fixed chelal finger with tactile seta *it* about midway between *et* and *ist* or somewhat closer to *et* than to *ist*, *ist* distinctly distal to the level of *est*, *est* located proximal to the midpoint of the finger and much nearer to *eb* than to *et*; nodus ramosus of movable finger at the level or proximal to the level of tactile seta *st;* chelal fingers with several accessory teeth; no vestigal venom duct in fixed chelal finger, but a trace of a duct appears to be present in the venedens in some individuals. Legs with surfaces not strongly granulate, investing setae acuminate to subclavate; fourth pedal tarsus without a tactile seta on the extensor surface, but a short subterminally paucidenticulate pseudo-tactile seta located proximal to the apical setae by a distance much less than the depth of the tarsus. Sperm receptacles of female relatively short, a little less than the distal one-half of each in the form of a weakly swollen, pyriform or cylindrical sac capped by a small cribriform plate.

Remarks: Turk's generic assignment of *Dinocheirus stercoreus* cannot be justified, since members of the genus *Dinocheirus* have four setae in the cheliceral flagellum and have a tactile seta on the fourth pedal tarsus. In the absence of an established genus to which the species may be assigned, it has been necessary to erect the genus *Tejachernes*. The new genus has affinities with a number of chernetin genera, such as *Chrysochernes*, *Zaona*, and *Wyochernes*, in which the flagellum has three setae and in which the tactile seta is absent from the fourth pedal tarsus. *Tejachernes* may also be related to *Chernes*, but there is some question about the actual presence of three setae in the flagellum of *C. cimicoides*, the type species of the genus. From these and other possibly related genera, *Tejachernes* differs in the absence of the subbasal tactile seta of the cheliceral hand and in the arrangement of tactile setae on the chelal fingers.

The genus contains only the type species.

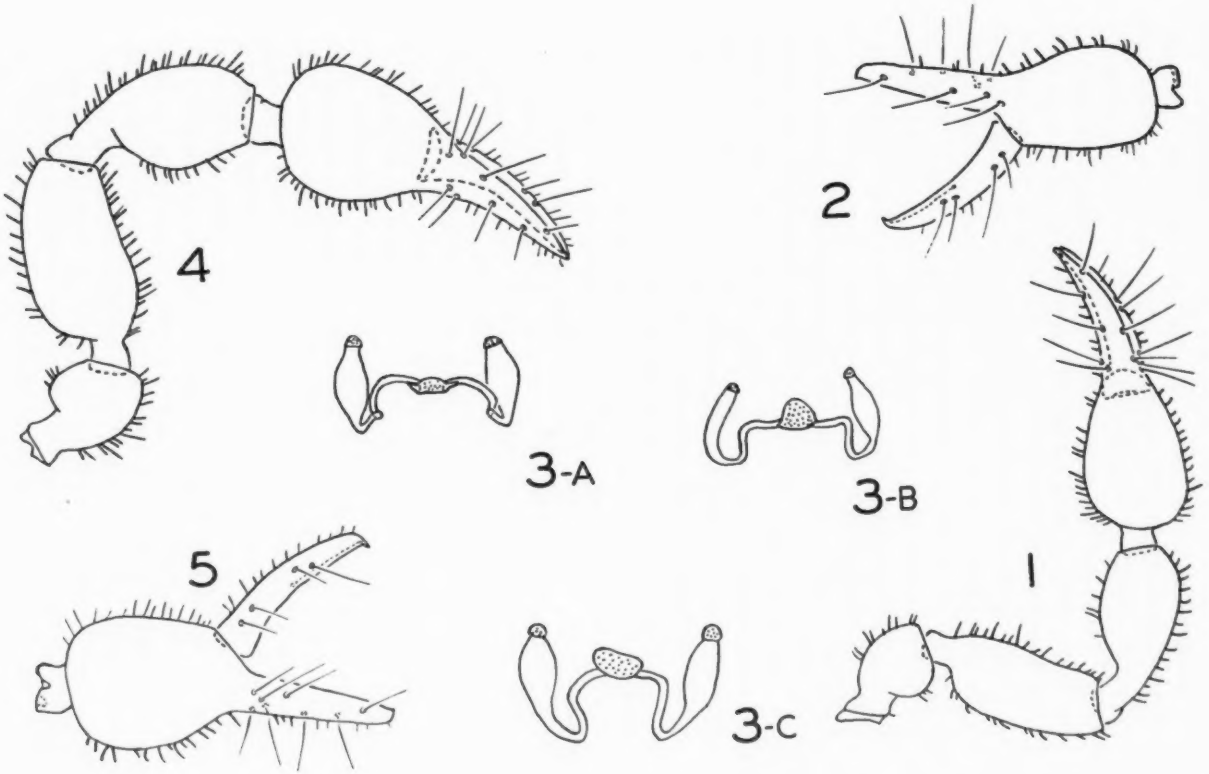
TEJACHERNES **stercoreus** (Turk, 1949), new combination.

Dinocheirus stercoreus Turk, 1949, Ann. Mag. Nat. Hist., ser. 12, vol. 2, p. 121, figs. 1–6.

Female: The description is based on 10 females, including eight topotypes from Bracken Cave, Comal Co., and two females from Frio Cave, Uvalde Co., Texas. Measurements and ratios of segments of the palpus and the fourth leg are given in the accompanying table. Body length 2.6–3.0 mm., except that in a few specimens the body is shorter as a result of the abdomen being strongly contracted. Carapace with 10 to 12 moderately clavate setae along the posterior margin; length of carapace 0.76–0.86 mm. Abdomen ovate in general outline; each tergal half of central part of abdomen with eight to nine, occasionally

seven or 10, marginal setae and one seta on the lateral margin; setae of sternites acuminate and approximately equal in number to the setae of the tergites of the central part of the abdomen; anterior stigmatic plate with two or three setae, posterior stigmatic plate with one or two setae. Chelicera moderately stout; surfaces of hand almost unsculptured, marked by no more than a few net-like lines near the base of the basal tactile seta; anterior blade of flagellum with six to 10 small spinules along the anterior margin; basal tactile seta with three to five spinules along the distal one-half; inner margin of fixed finger with three to five retroconical teeth and with three blunt denticles on the inner margin of the apical tooth; serrula exterior with 17 or 18, rarely 16 or 19, plates; galea fairly stout, with six or seven simple rami. Palps moderately stout, rich golden in color, surface of segments with weakly to moderately developed granules; setae of basal segments moderately clavate, becoming subclavate to merely paucidenticulate on the distal segments. Femur with pedicel nearly square in outline and well separated from the rest of the segment; flexor margin of femur flatly convex in central portion, but becoming more convex towards each end; flexor margin weakly S-shaped. Tibia with well-developed pedicel that is slightly longer than wide; extensor margin moderately convex but becoming slightly more convex near the distal end; flexor margin well rounded and much more strongly convex than the extensor margin. Chelal hand with extensor margin flatly convex, flexor margin regularly and more strongly convex, both margins merging without interruption into the basal margin; pedicel displaced slightly towards the flexor side of the hand; fingers relatively stout and gently curved. From the side, chelal hand fairly stout, both dorsal and ventral margins gently convex and merging without interruption into the basal margin; pedicel displaced slightly towards the ventral margin; fixed finger nearly straight, movable finger gently and regularly curved; about 40 well-developed and strongly cuspidate marginal teeth on each finger; accessory teeth variable, frequently each finger with about three exterior and six interior accessory teeth; tactile setae as shown in figures 1 and 2. Legs moderately stout; fairly deep yellow in color; surface weakly sculptured, except on the pars tibialis; setae of flexor surfaces of segments chiefly paucidenticulate, setae of extensor surfaces varying from multispinulate to subclavate. Anterior operculum of female genitalia with 25 to 35 setae arranged chiefly in a cluster anterior to the genital slit; posterior operculum with a transverse row of usually eight to 10 setae; lateral cribriform plates relatively large and irregular in outline; seminal receptacles as shown in figure 3.

Male: Description of the male is based on six specimens, three topo-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types from Bracken Cave and three males from Frio Cave. Measurements and ratios of palpal and pedal segments are given in the accompanying table. Male essentially like the female except that the seg-

Ranges of measurements and ratios of palpal and pedal segments of 10 females and six males, all mounted in Canada balsam. (* indicates length exclusive of the pedicel.)

	10 females	6 males
Palpal trochanter, length, mm.	0.34–0.36	0.36–0.39
width, mm.	0.21–0.23	0.23–0.25
length/width ratio	1.54–1.69	1.52–1.65
Palpal femur, length, mm.	0.53–0.60	0.60–0.65
width, mm.	0.225–0.245	0.275–0.30
length/width ratio	2.32–2.57	2.06–2.28
Palpal tibia, length, mm.	0.51–0.56	0.57–0.61
width, mm.	0.22–0.26	0.28–0.305
length/width ratio	2.08–2.31	1.97–2.07
Palpal chela, length, mm.*	0.86–0.95	0.93–1.02
width, mm.	0.28–0.34	0.345–0.38
length/width ratio	2.71–3.07	2.58–2.76
Chelal hand, length, mm.*	0.40–0.45	0.43–0.48
depth, mm.	0.285–0.345	0.365–0.39
Movable chelal finger, length, mm.	0.47–0.52	0.52–0.57
Fourth pedal femur, length, mm.	0.575–0.67	0.595–0.67
length/depth ratio	3.17–3.55	2.99–3.44
Fourth pedal tibia, length, mm.	0.47–0.545	0.50–0.57
length/depth ratio	4.40–5.06	4.37–5.14
Fourth pedal tarsus, length, mm.	0.35–0.40	0.39–0.43
length/depth ratio	4.66–5.00	4.65–5.12

ments of the palpus are somewhat larger and stouter. Length of body 2.3–2.6 mm.; carapace 0.77–0.82 mm. long. Chelicera with 17 plates in the serrula exterior. Palpus with surface sculpturing and chaetotaxy much as in the female. Femur with pedicel strongly set-off from the rest of the podomere, femur strongly bulging in the dorsal-flexor part just beyond the pedicel; tibia with pedicel little longer than wide, extensor margin somewhat strongly convex, flexor margin strongly convex and bulging in the central one-half; chela with pedicel near center of basal margin, extensor margin gently and somewhat weakly convex, flexor margin strongly convex, both margins merging without distinct interruption into the basal margin. From the side, chelal hand distinctly stout, with the basal-dorsal portion strongly swollen; ventral margin gently convex; dorsal margin more strongly convex; pedicel slightly closer to the ventral than to the dorsal margin; fingers much as in the female. Arrangement of tactile setae as shown in figures 4

EXPLANATION OF FIGURES. Drawings were made with a camera lucida and are of topotypes mounted in Canada balsam. Except for figure 3, all figures are drawn to the same scale. Teeth of chelal fingers not shown. Fig. 1. Dorsal view of palp, female.—Fig. 2. Lateral view of chela, female.—Fig. 3-A, -B, and -C. Ventral view of seminal receptacles, showing variation among three females. All are drawn to the same scale.—Fig. 4. Dorsal view of palp, male.—Fig. 5. Lateral view of chela, male.

and 5. External genitalia with anterior operculum bearing a median cluster of about 30 setae of varying length and a transverse row of about 10 relatively long setae posterior to the cluster and just anterior to the genital slit; posterior operculum with eight to 12 spine-like setae along the posterior margin of the genital slit and a transverse row of usually between 12 and 16 longer setae on the face of the operculum.

Tritonymph: The two tritonymph topotypes examined are similar to the females, except for the customary differences in size and chaetotaxy. As in the adult, the subbasal tactile seta is absent from the cheliceral hand.

Remarks: Most measurements given by Turk in his orginal description fall within ranges given in the present paper. Disagreements between Turk's description and the present specimens probably result from the small number and poor preparation of specimens available to Turk.

Records: BRACKEN CAVE, COMAL CO., TEXAS: One collection of topotypes, including six mounted females and one mounted male, as well as 21 nymphs in alcohol, from the under surfaces of rocks on bat guano, by J. S. Wiseman on July 30, 1954; the second collection, consisting of six mounted topotypes, two females, two males, and two tritonymphs, from bat guano, by R. B. Eads on April 17, 1956. FRIO CAVE, UVALDE CO., TEXAS: One collection consisting of one mounted female, one mounted male, and two females and one nymph in alcohol, from guano beneath a colony of bats of the species *Tadarida mexicana*, by J. S. Wiseman on March 20, 1955; a second collection including one mounted female, one mounted male, and one female and one nymph in alcohol, from swallow nests constructed from mud at cave entrance, by J. S. Wiseman on March 30, 1955; a third collection consisting of one mounted male taken from guano beneath a colony of bats of the species *Mormoops megalophylla*, by J. S. Wiseman on March 30, 1955. From these collections, some specimens have been retained by the author, some have been deposited in the American Museum of Natural History, and others have been forwarded to Dr. R. B. Eads of the Department of Health of the State of Texas, Austin, Texas.

LITERATURE CITED

TURK, F. A. 1949. *Dinocheirus stercoreus*, a new pseudoscorpion from the Bracken Cave, Texas, U.S.A. Ann. Mag. Nat. Hist., ser. 12, vol. 2, pp. 120–126, figs. 1–6.

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DISTRIBUTIONAL PATTERNS OF TEXAS FRESH-WATER FISHES

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ABSTRACT. Distribution patterns of most fresh-water fishes in Texas closely resemble those of terrestrial organisms, though there are 3 exceptional groups: (1) those limited by stream divides, (2) those of marine and freshwater forms meeting in fresh waters near the coast, and (3) certain species of northeastern Texas (Austroriparian) whose ranges include outliers or extensions into other biotic provinces. It is concluded that the basic factors controlling distribution patterns of fishes are climatic and geological, these determining the properties of the water.

In recent treatments on the biogeography of Texas, many distributional patterns have been delimited (Blair, 1950, and Tharp, 1939 and 1952). Although Tharp divided the state into more subdivisions than did Blair, the demarcation lines for his Vegetation Regions conform closely to those for Blair's Biotic Provinces and Districts (Fig. 1). In addition, Tharp emphasized differences associated with the coastal prairie more than Blair, who in turn separated the district known as the lower Rio Grande Valley more distinctly. Their areas approximate those of Johnson (1931) as both authors correlated the biologic distributions with geologic and climatological data. Obviously, the edaphic and climatic factors are critical to the survival of organisms in any region. Both Blair and Tharp base their conclusions chiefly on the distribution of terrestrial organisms. At least one group of aquatic organisms, the fishes, has distributional patterns that closely resemble those derived from terrestrial studies.

Correlation of fresh-water fish distribution with Life Zones in Texas as given by Bailey (1905) is not very close. The life-zone boundaries of Bailey that approximate the boundaries of Blair and Tharp fit the distribution patterns of fresh-water fishes, whereas no correlation is noted where Bailey's boundaries differ.

Additional support for the general validity of these boundaries can be derived from the geographic distribution of historic Indian groups. Kroeber's (1939) maps for Indian tribal areas roughly correspond with Blair's and Tharp's regions. T. N. Campbell (personal communication, 1957) reports that the correlation at about 1500 A.D. is perhaps even better than indicated by Kroeber. He would locate the Caddo and Atakapa Indians in the Austroriparian Biotic Province with occa-

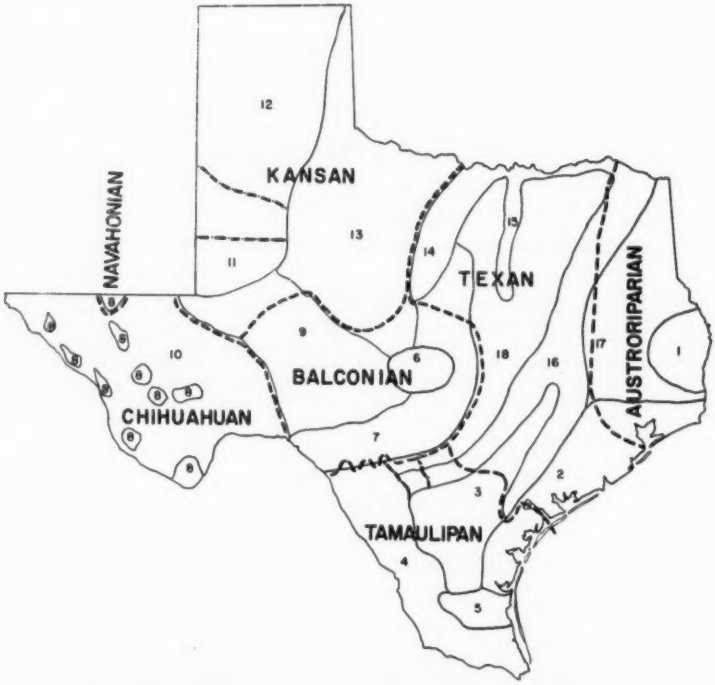

Fig. 1. Comparison of Vegetation Regions and Biologic Provinces in Texas. Compiled from Tharp (1952) and Blair (1949) resepctively. For clarity, sub-divisions are not included. Heavy lines and names show Biologic Provinces. Fine lines and numbers designate Vegetation Regions. (1) Long-leaf Pine, (2) Coastal Prairie, (3) Fayette Prairie and Transition Zone, (4) Mesquite-Chaparral, (5) Mainland Dunes, (6) Oak-Hickory-Mesquite of the Igneous Central Mineral Region, (7) Oak-Juniper of Hilly Marginal Portion of Edwards Plateau, (8) Montane Forests and Oak-Savanna, (9) Liveoak-Mesquite Savanna, (10) Foothills and Mesa Region westward from Pecos River, (11) Sandy South Plains, (12) High Plains, (13) Mesquite Savanna, (14) Western Cross Timbers, (15) Eastern Cross Timbers, (16) Oak-Hickory, (17) Mixed Pine-Oak, (18) Blackland Prairie.

sional hunting excursions into the Texan. The Karankawa Indians inhabited the Coastal Prairie west of the Austroriparian (perhaps not so far inland as mapped by Tharp). The Tonkawa Indians inhabited the Texan north of the Coastal Prairie before being partially replaced by Wichita Indian groups. The Tamaulipan Biotic Province was inhabited by Coahuiltecan Indians. The Indians inhabiting the Balconian before 1500 may have been Coahuiltecan but this has yet to be demonstrated. The rest of the state was inhabited first by Apache

Fig. 2. Major stream systems of Texas.

groups, which were later (after 1700) replaced in Texas by Comanches. Both Apache and Comanche raided in other areas. It is not suprising that Indian groups occupied similar areas as other biologic groups. Moreover, recent cultural groupings likewise appear to have had similar geographic limitations.

Knowledge of the distribution of Texas fresh-water fishes has accumulated for more than 100 years. Naturalists accompanying the Railway and Boundary Surveys in the 1850's collected a few fishes, especially on the wagon road between San Antonio and El Paso (Girard, 1858 and 1859). The next more or less intensive work was done in 1884 (Jordan and Gilbert, 1886) and 1891 (Evermann and Kendall, 1894). Locality data for many of the early collections are either inadequate or inaccurate (Clark Hubbs, 1954; Miller, 1955; and Clark Hubbs and Springer, 1957). Interest lagged again until the 1920's when Carl L. Hubbs, then at the University of Michigan Museum of

Zoology, started intensive studies of North American fresh-water fishes. Many collections from Texas waters were made in conjunction with these studies. Intensive surveys of Texas streams were initiated in 1938 by Dr. Kelshaw Bonham at the A. and M. College of Texas. This work was continued and data gathered by his successors and associates including F. W. Tabor, Cecil Reid, G. W. Soulen, F. T. Knapp, G. K. Reid, Jr., and R. J. Baldauf. Unfortunately most of the collection reports are not published and many of the specimens cannot be located. Field work at The University of Texas began in 1946 under the supervision of W. F. Blair. Since 1949 I have been in charge of this program. At about the same time the Texas Game and Fish Commission began intensive stream surveys at the instigation of Marion Toole. Additional information has been accumulated by Royal D. Suttkus, George A. Moore, Carl D. Riggs, and William J. Koster as part of their studies of adjacent states. Kirby Walker, Gordon Gunter, Henry Hildebrand, and J. L. Baughman have concentrated their studies on marine and brackish water environments.

Four zoogeographic summaries based wholly or in part on the distribution of Texas fresh-water fishes are available. Cope (1880), including few fishes, classified the Texas fauna as nearctic with some neotropical forms. Evermann and Kendall (1894) and Fowler (1945) discussed the forms by stream systems. Unfortunately they did not note that many fish distributions are not primarily limited by stream divides. Knapp (1953) partly escaped this pitfall. He separated the Navasota from other Brazos tributaries because of its eastern faunal affinities. He also separated the Sulphur and Cypress drainages from the other parts of the Red River System on his map but this may be an oversight as in the text he did not mention this separation. Otherwise he mapped the fish distribution by stream systems.

Evaluation of the natural distribution of fishes often is complicated by recent faunal modification. The distribution of such fishes as the basses *(Micropterus)*, crappies *(Pomoxis)*, sunfishes *(Lepomis)*, and catfishes *(Ictalurus)* has been modified by fish-cultural activities. Many species have been widely introduced for food *(Cyprinus carpio)*, by bait release (*Astyanax fasciatus*, *Semotilus atromaculatus*, *Notemigonus crysoleucas*, and other minnows), and by release from home aquaria *(Cichlasoma cyanoguttatum* and *Carassius auratus)*. Moreover, modification of the habitat by Anglo-American cultural activities may have changed many general patterns. As early collection records are often scanty, many of the conclusions are based on data obtained since 1950.

SPECIES LIMITED PRIMARILY BY STREAM SYSTEM

Stream divides obviously can limit the geographic range of fishes. Nevertheless only 35 species in Texas are exclusively or in large part limited to certain stream systems. Several ranges are in part based on stream divides. For obvious reasons such boundaries are less noticeable in terrestrial organisms. It is not surprising that the Rio Grande-Nueces and Red River-Sabine divides limit the largest number of species. The main streams are most widely separated geographically and downstream flood connections are less likely to occur (Fig. 2).

Rio Grande-Nueces divide:

Notropis jemezanus and *N. braytoni* occur in the Rio Grande and tributaries, the latter west through the Big Bend region only.

Rhinichthys cataractae and *Notropis simus* occur in the Rio Grande east to near Laredo.

Notemigonus crysoleucas, *Opsopoeodus emiliae*, *Ictalurus melas*, and *Etheostoma gracile* occur widely over Texas, especially in the lower Nueces but are probably not native to the lower Rio Grande (*I. melas* has been recorded there, probably a result of introductions). *Etheostoma grahami* is found only in the Devil's River and adjacent San Felipe Creek in Texas. Hubbs and Strawn (1957) questioned whether this form is specifically distinct from the allopatric *E. lepidum*. *Notropis proserpinus* (also in Lower Pecos), *Dionda diaboli* (also in Las Moras Creek), and an undescribed species of *Cyprinodon* (only in Devil's River) also are limited to this region in Texas. Their boundaries may be considered to be correlated with either stream divides or biotic areas.

Nueces-Guadalupe divide:

Notropis volucellus, *Hadropterus scierus*, *Etheostoma spectabile*, and *Percina caprodes* are abundant in the Guadalupe system and northern streams but absent from the Nueces. The *Percina*, however, also inhabits Rio Grande tributaries near the Devil's River. The cause of the range discontinuity is not known.

Guadalupe disjunct population:

Hadropterus shumardi is known in Texas only from the Guadalupe system east of the Balcones escarpment as well as east Texas. The cause of the range discontinuity is not known.

Colorado Disjunct Population:

Phenacobius mirabilis is limited chiefly to the part of the Colorado River east of the Balcones escarpment. It also occurs in northeast Texas. The cause of the range discontinuity is not known.

BRAZOS-TRINITY DIVIDE:

Moxostoma congestum is found in the Brazos east to the Coastal Prairie but is absent from collections from the adjacent part of the Trinity. It also occurs over much of south and central Texas.

TRINITY-NECHES DIVIDE:

Notropis sabinae, N. roseus, and *Hadropterus shumardi* are common east and absent west of this divide, which roughly corresponds with the eastern edge of the Austroriparian Biotic Province or mixed Pine-Oak Vegetation Region. The latter two species are also common in the lower Colorado, Guadalupe and Nueces systems and in the lower Guadalupe System, respectively. The causes of the range discontinuities are not known.

NECHES-SABINE DIVIDE:

Notropis chalybaeus has been taken occasionally east and not west of this divide.

RED RIVER-SABINE DIVIDE:

Esox niger, Moxostoma erythrurum, Notropis cornutus, N. ortenburgeri, Menidia audens, Stizostedion canadense, and *Etheostoma barratti* occur in the Red River System east of Lake Texoma and are absent from the Sabine and elsewhere in Texas.

Campostoma anomalum and *Etheostoma spectabile* have been taken in the Red River Drainage of eastern Texas but not from the Sabine. Both are common in limestone waters to the west.

Hiodon alosoides, Hybopsis storeriana, Notropis deliciosus, and *Notropis bairdi* are known from most of the Red River Drainage of Texas but not from the systems immediately adjacent to the south. *Notropis bairdi* and *N. buccula* are here considered specifically distinct. *Notropis deliciosus* is also found on the limestone hills of the Balconian Biotic Province as well as in northern Mexico.

RED RIVER-ARKANSAS DIVIDE:

Hybopsis gracilis and *Notropis girardi* are known from Texas only in the Canadian River and its tributaries, all of which drain into the Arkansas River (Cross, Dalquest, and Lewis, 1955).

COASTAL SPECIES

Fish distributional data logically support a major coastal biologic area. Many salt water forms invade fresh waters for varying distances (Gunter, 1945), but many of these distances are similar. Probably the distance inland fluctuates directly with the amount of salt water.

During the past several years of pronounced drought this area has been slightly narrower than Tharp's Coastal Prairie, and on the central coast corresponds rather closely with Campbell's outline of the range of the Karankawa Indians. The primarily marine species that occupy this area include *Elops saurus*, *Harengula pensacolae*, *Anchoa mitchilli*, *Bagre marinus*, *Galeichthys felis*, *Adinia xenica*, *Fundulus similis*, *F. grandis*, *F. pulvereus*, *F. jenkinsi*, *Mugil curema*, *Membras martinica*, *Gobionellus shufeldti*, *Microgobius gulosus*, *Gobiosoma bosci*, *Trinectes maculatus*, and *Achirus lineatus*. Most of the primarily fresh-water fishes do not penetrate into this brackish water area. A few do enter the habitat and occur there with forms that are primarily marine. Other primarily marine forms may extend farther into fresh waters. *Strongylura marina* has been taken as far up the Colorado River as Bastrop. *Cyprinodon variegatus*, *Menidia beryllina*, and *Lucania parva* are often found in the Rio Grande above Falcon Dam. Perhaps they occupy most of the Tamaulipan Biotic Province. *Lucania parva* has also been taken in the Pecos River.

SPECIES NOT PRIMARILY FOLLOWING TERRESTRIAL BIOTIC AREAS

Three distribution patterns that have not been mentioned by Blair or Tharp are apparent in fresh-water fishes. These distributions cross the boundary between the Texan and Austroriparian Provinces. I can find no geologic or meteorologic correlations with these patterns.

Lake Texoma to Panola County:

Ichthyomyzon castaneus, *Notropis maculatus*, and *Etheostoma histrio* are found north of this line, including parts of the upper Sabine, but not in the adjacent area to the south.

Upper Red River to Panola County:

Lepisosteus platostomus, *Ictiobus cyprinellus*, and *Notropis blennius* are found in the same general region as the previous group and also extend to near the Texas Panhandle in the Red River System. Gunter and Knapp's (1951) record of *L. platostomus* from near Port Lavaca is unconfirmed and is here considered dubious. Likewise, reports of *L. platostomus* from the Pecos (Evermann and Kendall, 1894, and Meek, 1904) are probably based on Girard's (1858) description of *Cylindraceus latirostris* which is probably a synonym of *L. spatula* (Carl L. Hubbs, personal communication, 1957). *Phenacobius mirabilis* occurs in this part of northern Texas and the lower Colorado System.

Fort Worth to Houston:

Minytrema melanops, *Notropis umbratilis*, *Schilbeodes nocturnus*, *Labidesthes sicculus*, and *Etheostoma radiosum* are found north and east of this line but not south and west of it. This line approximates that drawn by Knapp (1953) to divide his eastern and central geographic areas. It also approximates the line drawn by Kroeber (1939) for the western limits of the Caddoan Indians.

SPECIES THAT PRIMARILY FOLLOW TERRESTRIAL BIOTIC AREAS

The ranges of 79 fish species are entirely or in large part limited to the Biotic Areas based on the distribution of terrestrial organisms. Many of these fishes are common species the ranges of which are not likely to be modified by fishermen.

Austroriparian:

Fundulus notti, *Centrarchus macropterus*, *Elassoma zonatum*, *Morone interrupta*, and *Etheostoma proeliare* all have ranges that correspond with the western limit of the Austroriparian. With the exceptions of *M. interrupta* and possibly *C. macropterus*, they are forms not likely to be moved by fishermen. *Hybognathus hayi* probably has a similar range but records are scanty. The range of *Erimyzon oblongus* also corresponds with the Austroriparian; previous western records (Clark Hubbs, Kuehne, and Ball, 1953; and Clark Hubbs, 1954) are based on *E. sucetta*. *Notropis atherinoides* appears to range through the Austroriparian of Texas; however, confusion with a western form, *N. percobromus*, makes its range less certain. *Semotilus atromaculatus* also is abundant within the Austroriparian but seldom elsewhere in Texas. Western records in Texas, such as those so reported by Jurgens (1954), and a report from Lake Texoma have undoubtedly resulted from bait release.

The range of *Fundulus chrysotus* in Texas corresponds within the Austroriparian except along the coast, where it is found slightly farther west, to Matagorda County.

Mixed Pine-Oak—Oak Hickory Line:

In Texas seven species, *Ichthyomyzon gagei*, *Polyodon spathula*, *Moxostoma poecilurum*, *Fundulus olivaceus*, *Lepomis marginatus*, *Ammocrypta vivax*, and *Etheostoma parvipinne*, reach western limits the correspond with the western limit of the Mixed Pine Oak Region (No. 17 on Fig. 1), which extends slightly east of the western border of the Austroriparian in the northern corner of the state. *Ammocrypta*

clara appears to have a similar range but records are too scanty for a definite allocation of limits for this species. *Lepomis symmetricus* also occupies the same area to the north but on the coast it is found west to Matagorda County. These patterns are hardly significant deviations from the Austroriparian patterns.

Oak-Hickory—Blackland Prairie Line:

Amia calva, *Esox americanus*, *Notropis atrocaudalis*, and *Aphredoderus sayanus* reach western limits near this line (between regions 16 and 18, Fig. 1). All are limited on the southwest by a line between Brazos and Matagorda Counties. They therefore moderately transgress the Austroriparian.

Notropis fumus and *N. amnis* have similar western limits, but toward the southwest extended to the northern edge of the Tamaulipan Biotic Province.

The eastern limit of the range of *Pimephales promelas* coincides with this line north of San Antonio. This species is absent also in the Balconian Biotic Province (except for one specimen which was probably released as bait) and from the Rio Grande System of Texas (except in the Big Bend region).

Eastern Cross Timbers and Edwards Plateau—Blackland Prairie Line:

The western limit of *Etheostoma chlorosomum*, *Opsopoeodus emiliae*, and *Lepisosteus spatula* approximates this line, which cuts through the Texan Province in northcentral Texas (the northwestern tongue of the Blackland Prairie (No. 18 of Fig. 1) is not here included). On the south *E. chlorosomum* is absent in the Tamaulipan Biotic Province. *Opsopoeodus emiliae* occupies all but the Rio Grande drainage of the Tamaulipan in Texas. *Lepisosteus spatula* occurs throughout the Tamaulipan of Texas, and ranges farther.

In Texas *Campostoma anomalum* and *Etheostoma spectabile* reach their eastern limits on this line. The former occupies the entire Balconian Biotic Province and parts of the Rio Grande System. The latter is excluded from the Nueces System. On the west both are excluded from the Kansan Biotic Province in Texas. The eastern limits of *C. anomalum* are slightly obscured by occasional eastern records, but that of *E. spectabile* is remarkably precise. West of the Balcones escarpment it is usually the most abundant riffle-inhabiting fish. No specimens are taken in extensive collections as little as 10 miles east (downstream).

Texan Biotic Province:

Blair was unable to list any endemics for this primarily transitional Biotic Province. Three fishes, *Notropis oxyrhynchus*, *N. brazosensis*, and *N. potteri* are limited to this area. These species were originally thought to be limited entirely or almost entirely to the Brazos River System (Carl L. Hubbs and Bonham, 1951), but have since been taken in adjacent systems (Jurgens, 1954). *Notropis buccula* is also found only here, but is absent in the Red River System, where it is replaced by *N. bairdi*, with which it may be conspecific.

Three species, *Schilbeodes gyrinus*, *Fundulus notatus*, and *Micropterus punctulatus* occupy both the Austroriparian and Texan in Texas.

Four species, *Lepisosteus productus*, *Signalosa petenensis*, *Etheostoma gracile*, and *Mugil cephalus* occupy the Texan, Austroriparian, and Tamaulipan biotic provinces in Texas. *Etheostoma gracile* is absent in the Rio Grande drainage of the Tamaulipan. *Mugil cephalus* is primarily marine but its freshwater records closely approximate the listed geographic area.

Notropis venustus, *Ictalurus natalis*, and *Lepomis punctatus* occupy the Texan, Austroriparian, and Balconian biotic provinces in Texas. In Texas *Notropis volucellus* has the same limit, except that it is absent in the Nueces River Drainage. *Hadropterus scierus* also occupies the three biotic provinces but is absent in the Nueces System and on the coastal part of the Texan.

Balconian Biotic Province:

A number of fishes are entirely or chiefly limited to this Biotic Province, which is limited on the south and east by the Balcones Escarpment. The range of *Etheostoma lepidum* nearly coincides, if *Etheostoma grahami* is specifically distinct. If *E. grahami* and *lepidum* are conspecific, the Texas range of *E. lepidum* equals the Balconian. *Notropis amabilis* in Texas is limited to the Balconian. Established populations of the introduced *Lepomis auritus* are chiefly limited to this area, though some are found elsewhere, especially in farm ponds. A disjunct part of the range of *Notropis deliciosus* corresponds with the Balconian; other specimens are from northern Mexico and the Red River and northern drainages in the United States. *Notropis lepidus* and *Micropterus treculi* occupy the southern and northern halves of the Balconian, respectively. Both are essentially allopatric to closely related species (*lutrensis* and *punctulatus*).

Moxostoma congestum in Texas is chiefly limited to the Balconian, but does extend into the Chihuahuan and Texan to the Coastal Prairie and Brazos-Trinity divide.

Dionda episcopa is essentially restricted to the Balconian and Chihuahuan regions of Texas.

The Balconian fauna, like the Texan, is essentially transitional. It does include, however, more endemics. Five species are limited to small fractions of the Balconian and are discussed below.

KANSAN BIOTIC PROVINCE:

Only one fish, *Cyprinodon rubrofluviatilis*, is typically Kansan in Texas. It is restricted to the Mesquite Plains Vegetation Region (No. 13). The Kansan is essentially depauperate in fish fauna.

TAMAULIPAN BIOTIC PROVINCE:

Three fishes, *Cichlasoma cyanoguttatum*, *Mollienisia latipinna*, and *M. formosa* are essentially limited to the Tamaulipan. *M. formosa* is restricted to the extreme southern tip of the state. *Mollienisia latipinna* also occupies the coastal plain and has been introduced elsewhere (Brown, 1953).

The native range of *Astyanax fasciatus* in Texas is essentially limited to the Tamaulipan and Chihuahuan. It has been widely introduced elsewhere by bait release (Miller, 1952, Brown, 1953, and Riggs, 1954).

CHIHUAHUAN BIOTIC PROVINCE:

Fundulus zebrinus, *Lucania parva*, and another undescribed species of *Cyprinodon* occur abundantly in the saline waters of the Pecos but not in the nearby less saline habitats in Texas. Salinities as high as 25.1 parts per thousand and a yearly average of 12.6 ppt have been recorded from the Pecos at Grandfalls (Ireland, 1956). Although those are extreme values, annual averages in excess of 10 ppt are often reported. The Pecos is less saline south of Sheffield and contains a fish fauna similar to that of adjacent parts of the Rio Grande. *Fundulus zebrinus* may be conspecific with *F. kansae* (Miller, 1955). The former recently has been taken in the Big Bend region at Garden Springs, the mouth of Tornillo Creek, and the mouth of Terlingua Creek. As all three locations have been collected extensively (Carl L. Hubbs, 1940, and by the author) prior to collections containing large numbers of *F. zebrinus*, bait release seems the most likely source.

Three species, *Notropis chihuahua*, *Pimephales promelas*, and *Campostoma ornatum*, live in clear tributaries in the Big Bend region but not in adjacent streams. All three are commonly taken in the state of Chihuahua. *Pimephales promelas* also occurs in many other parts of the United States.

In Texas, *Cyprinodon elegans* and *Gambusia nobilis* have inhabited springs in the western tributaries of the Pecos River. The latter also

occurs in similar tributaries in New Mexico. Probably due to drought and competition with the introduced *G. geiseri*, the two species are decreasing in abundance in the eastern part of their ranges. Neither could be found at Comanche Springs during a visit in 1956.

Two species, *Chaenobryttus gulosus* and *Lepomis microlophus*, have been found throughout the state, except in the Chihuahuan Biotic Province. Both have been extensively introduced, and their native range in Texas is indeterminate.

NAVAHONIAN BIOTIC PROVINCE:

One species, the introduced *Salmo gairdneri*, is restricted to the Navahonian in Texas. As this species has been widely introduced, its survival only in McKittrick Canyon in the Guadalupe Mountains (Knapp, 1953) indicates the area to be biologically unique. Trout have been reported elsewhere in Texas but the reports are either unverified or based on extremely artifical conditions, *i.e.*, feeding, winter, survival, etc. The best hearsay accounts are for the Pecos River, prior to use of the non-saline headwaters for irrigation, when the river was more suitable for fish life. The fish described appears to be *Salmo clarki*. The specimen of *Gila nigrescens* from "Texas" may well have been from the Navahonian, a region it naturally inhabits. The exclusion of the Navahonian from Texas by Mecham (1955), based on herpetofauna, is not supported by fish distribution.

MISCELLANEOUS:

Nine species have distributional patterns that fit the terrestrial biotic areas, but do not belong in any of the above categories. *Percina caprodes* occupies the Austroriparian, Texan, Kansan, and Balconian (except the Nueces River drainage) biotic provinces. The disjunct population in the Devil's River area is probably native, as this fish is difficult to transport and little used as bait. *Pimephales vigilax* is known throughout Texas except for the Chihuahuan Biotic Province and high plains. The natural ranges of *Notemigonus crysoleucas* and *Ictalurus melas* occupy the Texan, Kansan, Austroriparian and Tamaulipan (except Rio Grande Drainage) biotic provinces. As both have been widely introduced, occasional specimens are found elsewhere. *Cycleptus elongatus* and *Anguilla rostrata* occupy the large rivers in the Tamaulipan, Texan, Chihuahuan, and Austroriparian biotic provinces. *Erimyzon sucetta* has been taken in the Austroriparian and Balconian provinces and on the Coastal Prairie. It is now exceedingly rare in the latter and probably will become extinct there due to drought and misuse of the land. Its preferred habitat there (shallow waters upstream from the main springs) is rapidly disappearing.

Stream courses through the Texan undoubtedly connected the Balconian and Coastal Prairie populations. *Lepomis humilis* ranges through the Kansan, Texan, and Austroriparian provinces to the Coastal Prairie, and also occurs in the Llano Uplift (No. 6, Fig. 1) of the Balconian Province. *Fundulus kansae* occurs in the Llano Uplift, the Cross Timbers(No. 14 and 15, Fig. 1) and the Kansan Province. A population in Waller Creek in Austin, now extinct, probably came downstream from the Llano area.

LOCAL ENDEMICS

Seven species have extremely small ranges. They can be considered restricted to stream systems or biotic areas.

Satan eurystomus and *Trogloglanis pattersoni* are blind catfishes known only from artesian wells near San Antonio (Carl L. Hubbs and Bailey, 1947).

Etheostoma fonticola and *Gambusia geiseri* naturally occur in Comal and San Marcos springs and adjacent waters downstream. Those are the two largest springs along the Balcones Escarpment. The former fish has not been collected elsewhere. The latter has been found elsewhere probably as a result of mosquito control introductions (Clark Hubbs and Springer, 1957).

Gambusia heterochir occurs in the headwaters of Clear Creek, Menard County. Clark Hubbs (1957) correlated its distribution with the abundance of a species of *Ceratophyllum*. During a recent trip (July, 1957) pH readings were made at several stations in Clear Creek. Readings from 6.2 to 6.7 (mean 6.4) were made where *G. hetrochir* abounds; readings of 6.4 to 6.6 (mean 6.5) were made where the fish is rare; and readings of 6.8 to 7.4 (mean 7.0) were made where *G. heterochir* has not been found. These pH's are extremely low for spring waters from the carboniferous limestone of the area. Perhaps the low pH's are correlated with the Permian inliers (Sellards, Adkins, and Plummer, 1933) that occur nearby.

Cyprinodon bovinus is known only from Leon Springs (Miller, 1951) and it apparently now is extinct.

Gambusia gaigei is now known only in Graham Ranch Spring in the Big Bend (Clark Hubbs and Springer, 1957). It formerly occupied a nearby spring at Boquillas (Carl L. Hubbs, 1940).

WIDE-RANGING SPECIES

A few fishes occur throughout Texas. The boundaries of those species cannot, therefore, be correlated with distributional patterns

within Texas. However, infraspecific groupings may be correlated in those forms studied. *Notropis lutrensis* from the Balconian have slenderer bodies than those from elsewhere. Populations of *Gambusia affinis* with strongly marked color patterns occur in the Nueces tributaries within the Balconian but not in downstream waters of the Tamaulipan. Two ranges of races of *Pimephales vigilax* are separated by stream divides in Texas by Carl L. Hubbs and Black (1947). These authors listed the races as *Ceratichthys vigilax* and *C. perspicuus*.

CONCLUSIONS

The distribution patterns of fresh-water fishes resemble closely those of terrestrial organisms. A large proportion of the ranges of the fishes end at approximately the same place as do those of terrestrial organisms. Additional species have very restricted ranges. Although distributional details may change with the accumulation of additional data, the pattern is expected to be consistent.

Deviations from the terrestrial pattern characterize the distribution of several fishes, including: (1) those limited entirely or partly by stream divides; (2) marine and freshwater forms that contact near the coast; and (3) a group of fishes the ranges of which in northeastern Texas include, in addition to the Austroriparian Province, triangles of varying sizes of other biotic provinces. The limitation to stream systems was expected, but its infrequency is notable. Headwater stream capture and downstream connections during flooding must have been frequent. The second category is typical of the distribution of coastal aquatic organisms. The third category is at present inexplicable; the data are too extensive to attribute the deviation in distributional patterns to incomplete records.

The agreement between the distribution of aquatic and terrestrial organisms is probably based on climatological and geological factors, which may be expected to determine the properties of the water. Waters in western Texas are more saline than those in the east. Waters from the limestones of the Balconian Province have moderate amounts of dissolved salts and have proportionally more Ca^{++}, Mg^{++}, and CO_3^{--} ions, whereas the waters of the Texan region are intermediate in salinity. Perhaps the increased endemism in the Balconian is associated with these factors.

Difficulties in rearing Austroriparian fishes in Austin, in water of Balconian origin, illustrates the basic significance of water chemistry. Similar high mortalities of Balconian species in waters with low pH (and probably few salts) support this hypothesis.

METHODS AND ACKNOWLEDGEMENTS

The nomenclature follows that of Moore (1957) with two exceptions: *Percina* and *Hadropterus* are considered distinct genera (Clark Hubbs and Strawn, 1957) and *Chaenobryttus gulosus* replaces *C. coronarius* (Bailey, 1956). Described ranges have been outlined from spot maps of each species. Questionable records and problem species are so indicated. Species with few records are not discussed if no distributional pattern is apparent.

Many workers have aided in assembling the data included in this report. Those mentioned in the all-too-brief historical accounts are only a few. W. Frank Blair, T. N. Campbell, and B. C. Tharp of the University of Texas, R. R. Miller and R. M. Bailey of the University of Michigan, G. A. Moore of Oklahoma A. and M. College, and Carl L. Hubbs of the University of California have read and criticized this manuscript. I thank them for their helpful suggestions. The conclusions, however, are my own.

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OBSERVATIONS ON THE NATURAL HISTORY OF FOUR SPECIES OF WHIPTAIL LIZARD, CNEMIDOPHORUS (SAURIA, TEIIDAE) IN TRANS-PECOS TEXAS

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ABSTRACT. During the summers of 1951 and 1952, observations were made of the activities of four species of *Cnemidophorus* (*perplexus, sacki, tessellatus, tigris*) at three stations in Brewster and Presidio counties, Texas. The activities reported upon include foraging habits, responses to heat, home range, and breeding activities.

The whiptails *(Cnemidophorus)* are members of the family Teiidae which is restricted to the Western Hemisphere. The genus comprises five species groups (Smith and Taylor, 1950) with a total of about 20 species. These range from about 45 degrees south latitude to about 45 degrees north latitude. The maximum diversity of the genus according to Burt (1931) is in North America. Seven species which represent three species groups are found in the United States. Six of these, representing two species groups, occur in Texas, and five are more or less sympatric in the Chihuahuan biotic province (Blair, 1940, 1950; Dice, 1943) of Trans-Pecos Texas.

During the summers of 1951 and 1952, field observations on the activities of four species were made in Trans-Pecos Texas. These observations were in connection with a study of the competitive relationships between the four species (Milstead, 1957b). Some of the data on foraging habits, temperature control of activity, home range, and reproduction did not prove to be of great importance in the study of competition. They are, however, of sufficient value to warrant recording and are here offered as a contribution to the ecology and natural history of these lizards.

The field work which forms the basis of this report was carried out over a period of six months during the summers of 1951 and 1952 at three stations in Trans-Pecos Texas: (I) the Black Gap Wildlife Management Area, 60 miles southeast of Marathon, Brewster County; (II) the Miller Ranch in the Sierra Vieja range, 11 miles west of Valentine, Presidio County, and (III) La Mota Rancho, 63 miles south of Marfa, Presidio County. Four species of whiptails, *C. perplexus* (see

Milstead, 1957a, for use of this name), *C. sacki*, *C. tessellatus*,[1] and *C. tigris*, occur in that portion of Trans-Pecos Texas within which these three stations are situated. The species and subspecies which occur at each of the stations are:

	I. Black Gap	II. Sierra Vieja	III. La Mota
C. perplexus	X	X	X
C. sacki semifasciatus	X		X
C. sacki exsanguis		X	
C. tessellatus		X	X
C. tigris marmoratus	X		X

METHODS

Foraging activities of the various species at the three stations were studied by following a number of individuals of each species and noting their behavior. Records were made of distance covered in foraging, rapidity of movements, diligence in seeking food, places in which food was sought, and behavior when food was found. Observations were made from a short distance away in the few instances where the lizard under observation would allow the observer to approach. In most instances, however, observations were made from a distance of 30 to 50 feet with the aid of 7 x 50 binoculars.

During the summer of 1951, studies were made to observe the effect of weather changes on lizard activity. Standard minimum and maximum temperature recording thermometers mounted in a standard weather box, a sling psychrometer, and a portable anemometer were used. Studies of air temperature did not prove to be very satisfactory in studying the responses of small ground-dwelling, poikilothermic animals to temperature changes. In 1952, body temperatures of the lizards and soil temperature were studied with air temperature. A sixes-type minimum-maximum thermometer and a Mason form hygrometer mounted in a weather box four feet above the ground, a black bulb thermometer, and a Shultheiz Museum Special thermometer were used. The use of an anemometer was discontinued after it was found that wind had no apparent effect on the activity of whiptails. The black bulb thermometer consisted of a standard —10° to 110° C thermometer with a carbon-blackened bulb hermetically sealed in a glass test tube. This type of thermometer indicates the maximum amount of heat available and, according to Cowles and Bogert (1944), more closely approximates the heat absorbed by a dark-colored animal

[1] Spelled *tesselatus* originally and in author's ms. The word is a Latin adjective, not one coined or compounded by the describer of the species. The original spelling is a simple error and has been corrected by the Editor, since according to the International Rules of Zoological Nomenclature a scientific name "must be a word that is either Latin or Latinized."

than does an ordinary thermometer. This thermometer was used in determining soil temperature. In order to record the soil temperature, the bulb was buried in about a half inch of soil. By this method it was possible to protect the bulb from the direct rays of the sun and still keep it out of the slightly cooler temperatures which exist deeper in the soil.

The Shultheiz thermometer was used to check the body temperatures of the lizards. This is a small thermometer, calibrated from 0° to 50° from which a temperature reading can be made within 15 seconds. According to Cowles and Bogert *(op. cit.)*, the body temperature of a lizard may vary within a few degrees in less than 30 seconds. This type of thermometer gives a more accurate reading than would most thermometers. In order to take the body temperature, a lizard was killed with dust shot and the thermometer was inserted in the cloaca immediately afterwards. This method was checked with live, captive lizards under almost identical environmental conditions and virtually no differences in temperature were found between the dead individuals and the live captives.

Three methods of capture were used to study home range before a successful method was found. The first method attempted was to provide shelter traps in which the lizards could take refuge. These consisted of small baking powder cans having a screw cap on one end and a small hole in the other. These were set out under bushes in a grid pattern and theoretically should have worked as well as the funnel traps which Fitch (1951) found to be effective. The cans, however, did not prove to be successful. This was possibly due to the high temperature in the closed space, although they were shaded from the direct rays of the sun by pasteboard roofs placed over them. The second method used was a noose on the end of fly rod. This proved to be unsuccessful because of the difficulty of approaching some species close enough to use the noose.

The third method employed was the drift-fence-trap method. This was used at the Black Gap area during the latter part of the summer of 1952 and was found to be successful. The traps were constructed of quarter-inch-mesh hardware cloth and were two feet long and 10 inches square. The funnels were six inches long and tapered to an opening about two inches square. At first, trap doors were used to cover the openings, but they were discontinued after it was found that the lizards would not push them open to enter the traps. The drift fences were made of the same material as the traps and were 10 inches high. Eight traps and 300 feet of fence were used, and were placed in a more or less north-south line. Originally, six traps were placed 50 feet apart,

with a 25 foot wing extending out from each end trap. Later, two extra traps were added to the ends of these short wings so that both ends of the fence terminated in a trap. The bottoms of the fences were buried an inch or two in the ground to keep lizards from going beneath them, and the floors of the funnels were covered with dirt to provide more or less natural ramps into the traps. Some difficulty was experienced in keeping the fences tight to the ground. Livestock and deer frequently kicked up the fences and damaged them and cloudbursts washed them out twice. Toward the end of the trapping period, lizards that had been trapped repeatedly began to dig tunnels under the fences and some learned to climb them.

After a lizard was caught, it was permanently marked by toe clipping and temporarily marked by painting a number on its back with a quick-drying lacquer. These painted numerals remained legible anywhere from 24 hours to two weeks, dependent upon abrasion and ecdysis. When a marked lizard was observed, its location was recorded in number of paces from the nearest trap. Recovery was thus not dependent upon recapture. This method was not put into use until the end of the second summer, when the traps were in operation for only two weeks. The information obtained is, therefore, not conclusive but it does offer an indication of the activity range of these lizards and suggests some other interesting possibilities.

Studies on the reproduction of whiptails were done in the field and in the laboratory. The field work consisted of making notes on breeding behavior and on the appearance and increase of juveniles toward the end of each summer. Laboratory studies consisted of taking notes on the number of eggs contained in the females.

FORAGING ACTIVITY

The foraging habits of the four species of *Cnemidophorus* found in Trans-Pecos Texas vary slightly with the species but do not appear to vary geographically. The few differences in foraging habits which do exist are largely due to the differences in temperaments of the four species. The small species, *perplexus*, is not easily excited, while *tigris* is a nervous and wary lizard. The temperaments of the other two species, *sacki* and *tessellatus*, fall about midway between these two extremes. These differences in disposition of the four species are reflected in rapidity of movements and, consequently, in distance covered and diligence employed in searching for food.

The movements of *tigris* during foraging are rapid and jerky, while those of *perplexus* are slow and methodical. This latter species rarely seems to get in a hurry and, consequently, it is a very diligent forager.

An individual of this species may spend as much as five minutes examining a single small bush. In its examination, it searches under every twig and small stone around the base of the bush and then ascends the main trunk and goes out onto every branch. An individual of *tigris* is not nearly so careful in its examination of a bush. It makes a hasty search under the sticks and stones around the base and then makes a cursory examination of the main trunk without bothering to do more than glance out onto the branches. As a consequence, *tigris* covers about twice the distance in foraging as that covered by *perplexus* in a given length of time. The behavior of *sacki* and *tessellatus* in foraging is not as meticulous as that of *perplexus* nor is it as hasty as that of *tigris*. The distance covered by these two species in a given length of time is not quite one and a half times that of *perplexus*. In a half hour of foraging, *perplexus* will cover about 80 yards, *sacki* and *tessellatus* about 100 yards, and *tigris* about 150 yards. These figures are, of course, dependent upon the abundance of food and other factors.

When an observer approaches an individual of *perplexus*, it first shows momentary fear, then curiosity and finally complete unconcern. The behavior of *sacki* and *tessellatus* is very similar, but they are slower to become accustomed to the observer and never completely lose their wariness. It was found that, after a brief period of motionless observation from a short distance, an observer could approach to within five feet of individuals of any of these three species without their running away. On the other hand, individuals of *tigris* never lose any of their wariness and it was found that this species could not be successfully observed from a distance of less than 20 to 25 feet.

The places in which food was sought and the behavior when food was found did not appear to vary either interspecifically or geographically. Most of the foraging activities consisted of searches for termites, the staple food (Milstead, 1957b), and all of the species at the three stations had the same general pattern of foraging. The lizards sought termites under everything that might possibly conceal them. The typical procedure was to turn over small sticks and stones with the nose, and to dig around the bases of trees and bushes and under the edges of cow chips with the feet. In digging, several strokes were usually made with first one forefoot and then the other, as Smith (1946) has reported. Most of the termites that were found while lizards were under observation were in adobe "castles" around sticks and twigs. Whiptails showed remarkable technique in opening these castles to get to the termites. If a whiptail found a termite castle around a small stick, it would insert its nose under the stick and flip the entire castle into the air. As the stick hit the ground, the impact would shat-

ter the castle and the lizard would immediately advance and begin devouring the termites. Usually one flip was sufficient to break the castle, but occasionally a stick would have to be tossed into the air two or three times. When a termite castle was discovered around a larger stick, which the lizard could not lift, the usual practice was to steady the stick with one forefoot and root the castle open with the nose.

Aside from searching for termites, foraging activities consisted of looking for other food items on the ground and in bushes. One common practice, which was observed in all species, was jumping from the ground up to low branches on which moths or other large insects were resting. Once it had sighted an insect on a low branch, a whiptail would advance to a position under the branch, stop, look up, flex its muscles, jump, seize the branch with its forelegs, pull itself up, and then lunge at the insect. Running starts rarely preceded the jumps. This method of catching food appeared to be fairly successful, but frequently the commotion would frighten the insect off before the lizard succeeded in getting all of its body up on the branch. The highest jump that a lizard was seen to make without a running start was measured and found to be 18 inches. This jump was made by an individual of *Cnemidophorus tigris* at Station I, while it was attempting to get a moth that was resting on a low branch of a creosote bush *(Larrea divaricata)*. The disturbance caused by the lizard when it pulled itself up on the branch caused the moth to fly. It landed on another creosote bush about 10 feet away. The lizard dropped to the ground and ran to the second bush where it again frightened the moth. This time the moth flew out of sight.

Although many grasshoppers were found in the stomachs of these reptiles, a whiptail was seen to catch and subdue a grasshopper only once during the two summers of field work. In this case, the lizard was an individual of *Cnemidophorus tessellatus* at Station II. It had been under observation for some time before the grasshopper was found; so its entire behavior from the time the insect was first discovered until it was devoured was observed. The whiptail first sighted the grasshopper around the edge of a large stone. As soon as it saw the insect, the lizard stopped, its whole body became tense, and its tail began to twitch. After a few seconds of this, the lizard charged around the edge of the stone and seized the grasshopper by the head. A struggle ensued which lasted until the lizard succeeded in swallowing the grasshopper's head. The thorax and abdomen were rather large for the lizard's gape and its experienced some difficulty in swallowing them. The total time that elapsed from the time the grasshopper was first sighted until the last of it was swallowed was eight minutes.

The lizards do not have any apparent preference for the kind of plants around which they forage. Whiptails were seen to investigate everything from smooth grasses, creosote bushes, and yucca (*Yucca* spp.) to spiny mesquite trees *(Prosopis juliflora)*, sotol *(Dasylirion leiophyllum)*, and tasajillo *(Opuntia leptocaulis)*. In one case at Station I, an individual of *Cnemidophorus sacki* was seen to roll over on its back and use its mouth to remove a large prickly pear spine from its groin.

TEMPERATURE CONTROL OF ACTIVITY

The foraging activities of whiptails are altered during the day by fluctuations in temperature. When activity first begins in the morning, the lizards are very wary and easily frightened. Foraging activities at this time take place both in the shade of bushes and in open areas between bushes. Individuals frequently stop in level places or crawl up on flat rocks to bask in the sun. As the temperature increases during the morning, activity becomes more and more restricted to shade, and resting stops in the shade gradually replace basking stops. Toward the latter part of the morning, foraging is entirely restricted to shade, and individuals travel at a rapid pace when passing from the shade of one bush to the shade of another. About noon, foraging altogether ceases and the lizards lie motionless in the shade of bushes. They are very reluctant to leave these shady spots, and when forced to flee they usually do not run farther than the next bush. As the temperature continues to increase, the lizards retreat underground where they remain until the latter part of the afternoon. Activity begins again in the late afternoon, about an hour after the maximum temperature of the day has passed, and lasts until about sunset. The afternoon period of activity is similar to the morning period except that it is shorter and the reactions to temperature are in reverse order. When activity first begins in the afternoon, individuals are reluctant to leave shade, but as sunset approaches they become more wary, and frequent stops are made in order to bask.

These responses to temperature do not appear to vary either interspecifically or geographically. The soil temperature appears to provide the main control of lizard activity at all three stations. In all cases, activity began between 7:00 and 9:00 A.M. when the soil temperature reached 28 to 30° C. and ended between 11:00 A.M. and 1:00 P.M. when the soil temperature reached 50 to 52° C. The maximum daily temperature of both soil and air usually came a few minutes before 4:00 P.M. Afternoon activity began shortly before 5:00 P.M. when the soil temperature had fallen between 51 and 48° C. It ceased shortly

before sunset when the soil temperature had fallen to about 35° C. The body temperature of the lizards during their normal activity range was found to vary from 36 to 40° C. ("Normal activity range," as used here, includes the "basking range" and "maximum voluntary tolerance" of Cowles and Bogert, 1944.)

The close correlation between whiptail activity and soil temperature, the absence of correlation between activity and air temperature, and the small degree of correlation between air temperature and soil temperature suggest that soil temperature is the factor which controls *Cnemidophorus* activity. At the three stations, the soil temperature rises at a much higher rate in the morning than does the air temperature, and falls at a much faster rate in the afternoon. In the first hour after sunrise, the soil temperature may rise as much as 15° C. while the air temperature rises less than 10° C. *Cnemidophorus* activity was found to begin in the morning within an air temperature range of seven or eight degrees, depending upon the minimum temperature the preceding night, while it was found to begin within a soil temperature range of only two degrees. The lack of correlation between activity and air temperature is more clearly seen in the afternoon temperatures. It was first decided that air temperature had little or no effect on lizard activity during the summer of 1951, when it was noticed that, although activity would cease about noon at an air temperature of 38° C., it would resume at about 5:00 P.M. at a temperature of 46°. This phenomenon may be easily explained on the basis of soil temperature. In the summer of 1952, it was found that the soil temperature may fall nearly 10° in the first hour after the maximum temperature of the day has been reached, while the air temperature falls less than a degree. The rapid rate of decline of the soil temperature as opposed to the slow rate of decline of the air temperature is explained by Geiger (1950, p. 140). "Sandy soil [such as that found at all three Stations] heats up to an extraordinary degree in its uppermost layer, more so, even than does granite. But the temperature decreases very rapidly both upward and downward. Like granite, it is a dry soil, but has much lower heat conductivity on account of the air spaces between the sand grains. The day's heat does not penetrate so deeply as in granite; at 60 cm. depth there is practically no evidence of daily fluctuation." Radiation from the soil after the source of heat has been removed is more rapid than radiation to it, and, because sandy soil does not heat deeply, the high amount of heat gained by the soil during the day is returned to the air in a very short time.

The rapid decrease in temperature downward in a sandy soil is clearly shown by the fact that whiptails dig very shallow holes and

yet survive in them in unshaded areas when the soil temperature at the surface exceeds their maximum voluntary tolerance by 10 or 15° C. The holes of all of the species are constructed in the same manner. A typical hole consists of a straight tunnel located one and a half to two inches below the surface of the ground with a gentle slope upward to the surface at each end. The level part of the tunnel is usually just long enough to contain the occupant when it is stretched at full length. Even at this short distance below the ground, there is a considerable difference between the temperature of the hole and the temperature at the surface. At Station II in the summer of 1952, an individual of *Cnemidophorus perplexus* was observed to return from a foraging trip and enter its hole. After a few minutes, it was removed from its hole and temperatures were taken. These temperatures were as follows: air, 27.8° C.; soil at surface, 42.4° C., level part of hole, 35.4° C.; and body temperature of lizards, 36.4° C. This shows a difference of seven degrees between the temperature of the soil at the surface and at two inches below ground. It also shows a temperature difference of 14.6° C. between the soil surface and the air, and a difference of seven degrees between the temperature of the soil at the surface and at two inches below ground. It also shows a temperature differencec of 14.6° C. between the soil surface and the air, and a difference of one degree between the body temperature of the lizard and the temperature of its environment.

That soil temperature is the factor that controls *Cnemidophorus* activity is perhaps best seen in fluctuations in the soil temperature during the day. Due to the rapid cooling of sandy soil when the source of heat is removed, passing clouds which come between the ground and the sun serve to lower the soil temperature temporarily. They have no apparent effect unless they come near the end of the morning period of activity. At this time passing clouds, which cause the soil temperature to fluctuate within a range of three to five degrees Centigrade, become very important and cause activity to alternately cease and resume. Cloudy afternoons, which are of frequent occurrence on the Chihuahuan desert, may run the morning and afternoon periods of activity together or completely eliminate the latter. Morning overcasts do not have as pronounced an effect as do those of the afternoon. Activity does not begin until the clouds part and allow the sun to raise the soil temperature. The morning and afternoon periods of activity are still distinct, however, because the soil temperature rises rapidly once it begins to do so. A cloudy morning, therefore, does not affect the afternoon period of activity but serves only to restrict the morning period. Complete overcasts which last all day have a very pronounced

effect in that the soil temperature may never reach the basking range of the lizards. *Cnemidophorus* activity is thereby eliminated for that day. At Station I in July, 1952, a three-day overcast eliminated all activity until mid-afternoon of the third day. At that time, the sun showed hazily through the clouds, and a few whiptails came out for a short time. Rain caused these lizards to seek refuge immediately, even before the soil temperature had time to drop. Individuals which were active when a sudden cloudburst started sought shelter as soon as the first large drops began to fall.

HOME RANGE

Home range studies were made at the Black Gap Wildlife Management Area during a period of two weeks from July 13 through July 26, 1952. During this period of study, 38 individuals of *Cnemidophorus tigris* and five of *Cnemidophorus perplexus* were captured, marked, and released. None of the latter was recovered but 23 of the former were recovered at least once for a total of 84 recoveries.

Thirty individuals of *Cnemidophorus tigris* were marked during the first four days of study. The remaining eight were marked at the rate of one or two a day during the subsequent 10 days of the study. It may be presumed that some of these 38 individuals were transients and that the majority of the 23 individuals, for which there was at least one recovery, were residents. It is probable, therefore, that many of the transients and most of the residents of the trap area (about one acre) were marked during the first four days of study, and that all of the residents were marked during the two-week period. It may also be surmised that the trap line passed through the areas of greatest activity of the individuals for which there were several recoveries, while it passed through outlying parts of the home ranges of individuals for which there were few recoveries.

Six individuals were recovered seven or more times. Of these, two were females, while the other four were males. Two were recovered only in traps and, because the traps were arranged in a more or less straight line, nothing can be concluded about the sizes of their home ranges. The ranges of four lizards are shown in Fig. 1. These ranges were obtained by connecting the outermost points of recovery or observation.

Because one lizard was recovered at least once on 10 of the 14 days of study, it may be assumed that its home range is not much larger than that shown in Figs. 1, 2. The recoveries of each of the other three individuals numbered only about half of those above. Although none of these ranges may be considered as complete, two things are indi-

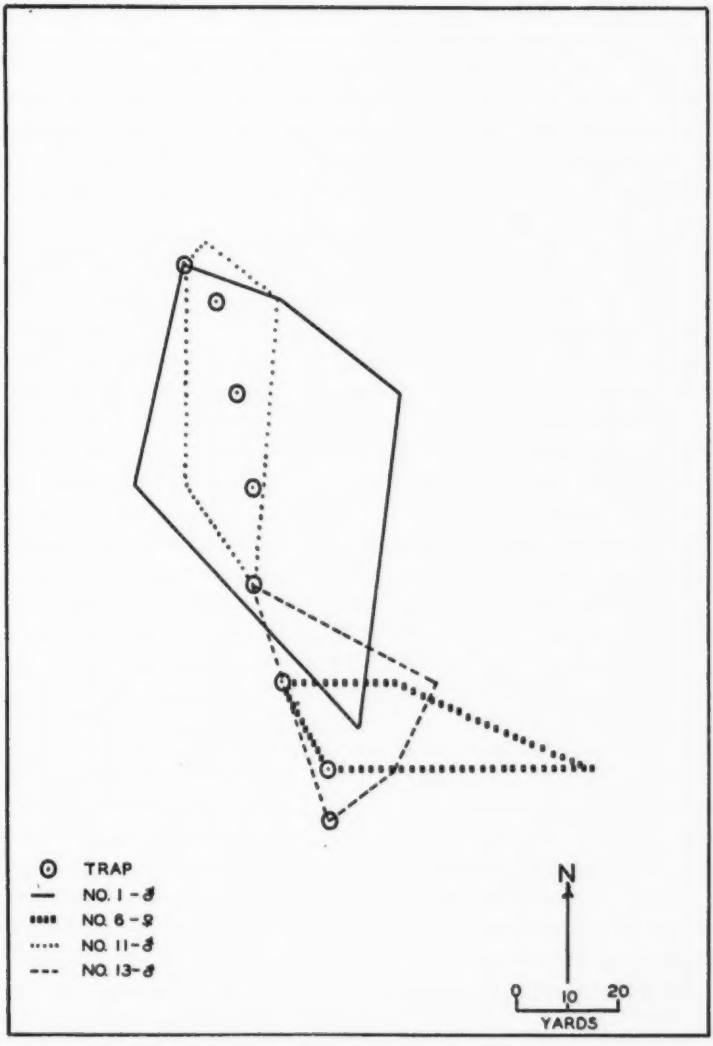

Fig. 1. Diagram of the home range of four individuals of *Cnemidophorus tigris* at Station I.

cated. First, the large amount of overlap of the ranges of two of the males (Fig. 1, nos. 1 & 11) suggests that, although these lizards have home ranges, they do not have territories. Second, there is an indication that these lizards may have permanent mates. A female and a male were recovered eight and nine times, respectively. In these recoveries, they were recorded together five times. In one instance, the female was in a trap and the male was just outside it. Both were frantically trying to get through the wire that separated them. This may be an indication of pairing or it may be merely coincidence. Their ranges do not coincide exactly and, also, the records are too few to be conclusive.

The records of the whiptail for which there were 17 recoveries, are plotted in Fig. 2. A solid line connects the outermost points within which all but one of the recoveries were made, and a broken line connects the one recovery made a considerable distance from the others. The area enclosed by the solid line equals 0.26 acre, while the entire home range covers 0.53 acre. Two of the 17 recoveries were made early in the morning and two were made just before *Cnemidophorus* activity ceased around noon. All four of these records were within a small area bounded by records A, C, and L (Fig. 2). Although this lizard was not seen to enter or leave a hole during the period of observation, it may be assumed, on the basis of these recoveries, that its hole was located somewhere within this small area. That 16 of the records of this lizard are grouped in one end of the home range, while one is somewhat removed, suggests that the home range of this species may be divided into two parts: an area in which most of the activity takes place, and an outlying area into which occasional forays are made. If this is the case, then the few recoveries of so many individuals is explained by the trap area cutting through the outlying regions of their home ranges, as has been previously suggested. The number of recoveries is, therefore, indicative of the distance of the trap area from the lizard's area of greatest activity. These assumptions are not conclusive, however, for two reasons. First, the painted numerals on the backs of the marked individuals by which most recoveries were made, frequently became erased after 24 to 48 hours. Marked individuals therefore could not always be recognized as marked individuals and this could lead to error in the number of recoveries of an individual that had lost its number. Second, the short duration of this phase of the study (14 days) makes it impossible to draw any definite conclusions other than that individuals of this species do have home ranges.

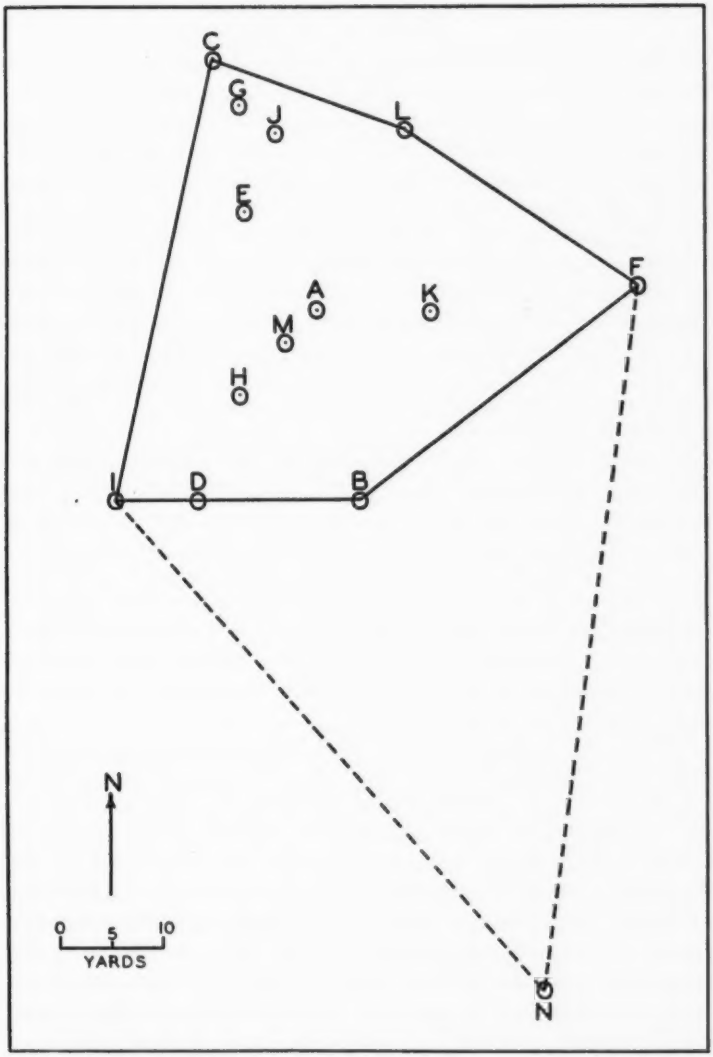

Fig. 2. Diagram of the home range of *Cnemidophorus tigris* No. 1 which shows the points of recovery. The dates of recovery at these points were (A) July 13 and July 20, (B) July 13 and July 22, (C) July 14 and July 17, (D) July 14, (E) July 14, (F) July 15, (G) July 16, (H) July 16, (I) July 16, (J) July 16 and July 24, (K) July 16, (L) July 16, (M) July 19, and (N) July 21. Points A,B,C, and J were trap sites. The recoveries at these points were recaptures.

REPRODUCTION

Mating behavior was observed twice during the field work. It was observed on the morning of June 18, 1951, at Station I and on the morning of July 31, 1952, at Station III. Individuals of *Cnemidophorus tigris* were involved in both cases. In the first instance, a female was observed moving at a rate more rapid than the usual foraging speed, while a male followed immediately behind her. After a short distance, the female stopped and the male attempted to mount. He succeeded in reaching a position on her back with his nose just behind her forelimbs and his forelimbs around her middle. At this point, the female shook herself and dislodged him. The male attempted to mount a second time and this produced the same result. After the male was dislodged for the second time, the tandem following began again. Shortly thereafter, the pair was lost in dense brush and no additional observations could be made.

In the second case, actual copulation between two large adults was observed. These two adults were first observed in the copulatory position and, therefore, no information on preliminary behavior could be noted. When first seen, the male was on top of the female with his forelegs clasping her just anterior to her forelegs and his hind legs clasping her just anterior to her hindlegs. Their tails were entwined and both were listing about 45 degrees to the left. At the approach of the observer, the lizards held this position at first but soon separated and took refuge in a bush. When the observer approached the bush, they fled to separate bushes.

No female was observed in the act of depositing eggs, nor were any clutches of eggs found during the field work. Eggs contained in the specimens that were opened for stomach analysis numbered from two to four in most cases. A few individuals of all of the species at all of the stations contained only one egg, and a very few individuals of *sacki* from Station II contained five or six eggs. In individuals which contained more than two eggs, it was found that the eggs were in different stages of development. Apparently no more than two eggs reach maturity at the same time. In cases where two eggs had reached the latter stages of development, it was found that theye were arranged lengthwise in the body cavity, one on either side of the mid-line. They completely filled the lower part of the coelom and crowded the viscera far anterior to their normal position. It is apparent that it would be a physical impossibility for more than two eggs to reach this size at the same time. No correlation between season and number of eggs and stages in the development of the eggs could be found. Mature eggs,

complete with shell, were found in the oviducts of specimens collected in early June and in late July, and immature eggs were found in specimens collected throughout the summer.

Mating in both early and late summer and mature eggs in the oviducts in both early and late summer indicates that either there is more than one breeding season per summer or that the breeding season is continuous throughout the summer. The presence of immature eggs in females throughout the summer seems to favor the latter possibility. Hamlet (1952) has proved fairly conclusively that *Anolis carolinensis* has a single breeding season which lasts throughout the summer and has shown that no more than one egg is ovulated at a time. He is of the opinion that each ovulation must be preceded by a separate insemination. The fact that mating activities of *Cnemidophorus* occur in both early and late summer appears to support this theory.

Juveniles do not begin to appear until the latter part of the summer. In 1951 the first ones were seen on August 3, and in 1952 they were first seen on July 30. This indicates that either the females carry the eggs well into summer or that incubation requires 45 to 60 days. The presence of mature eggs, complete with shells, in the oviducts in early June seem to support the latter possibility. During the month of August, the juveniles gradually increase in number and by the last week in August they make up the bulk of the population. By the first week in September, the adults have been almost entirely replaced by juveniles. What happens to the adults during the latter part of August is something of a mystery. One explanation is that the young are able to utilize the available heat more efficiently because of their increased surface area in proportion to volume (Cowles, 1941). During July and the first part of August, whiptail populations are predominantly composed of adults, but in early September, late May, and early June, the populations are predominantly composed of juveniles. These conclusions were reached on the basis of field observations, and in order to test them the snout and vent length measurements of 55 specimens of *Cnemidophorus perplexus* from Station II were taken. Of these 55 specimens, 34 were collected in late July and early August, 1951, and 21 were collected in late May, 1952. The measurements of these specimens are grouped as follows:

	Under 50 mm.	Over 50 mm.	Average lg.
August	7	27	53.47 ± 0.60
May	14	7	48.85 ± 1.15

It can be seen from these data that the adults exceed the young by nearly four to one in early August, while the young exceed the adults

by two to one in the spring. This indicates that a population of whiptails during any given summer (breeding season) is largely composed of yearlings. What happens to the adults over the winter is a question that is not easily answered. A possible explanation, however, is again that the young may have a higher survival value through greater heating efficiency as a result of greater surface area in proportion to volume.

SUMMARY

During the summers of 1951 and 1952, observations were made of foraging activities, responses to heat, home ranges, and breeding activities of 4 species of *Cnemidophorus (perplexus, sacki, tessellatus, tigris)* at 3 stations in Trans-Pecos Texas (Brewster and Presidio counties). The only observed differences in foraging habits between the 4 species appeared to be reflections of differences in temperament, nervous and wary species not being as meticulous as less excitable ones. The most diligent foraging activities for all consisted of very adept searches for termites. Foraging for these and other insects carried the animals into all types of vegetation without apparent preferences.

Two responses to daily temperature rhythm permit the lizards to keep their body temperatures within rather narrow limits. First, their activities are divided into morning and afternoon periods to fit more or less definite ranges of soil temperature. Second, within these periods, whiptails show microhabitat selection by basking in the sun during the cooler parts of the soil temperature range and by seeking shade during the hotter parts.

Recoveries of marked individuals in the home range studies were too few for any conclusive remarks. A few things are indicated however: (1) these lizards do have definite home ranges but lack territories which are patrolled and defended; (2) the home range may be divided into an area of greater activity and a contiguous area of lesser activity; and (3) there is a slight indication that these lizards may have permanent mates.

Mating of whiptails in early and late summer and the presence of mature eggs in the oviducts throughout the summer indicate that these lizards have a single breeding season which lasts throughout the summer. The size of mature eggs in the oviducts implies that it would be a physical impossibility for more than two eggs to mature simultaneously. The young of all species begin to make their appearance around the first of August and have largely replaced the adults by the first of

September. The evidence obtained implies that most of the adults of any given year are the young of the preceding year.

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FALL FOODS OF GAMBEL'S QUAIL (LOPHORTYX GAMBELII) IN NEW MEXICO

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ABSTRACT. The results of crop analyses of 57 Gambel's quail, collected in the Rio Grande drainage area of New Mexico during October, November, and December are reported. Of a food content totalling 178.9 cc., 91.6% consisted of seeds and fruits (mainly seeds), and 6.5% of greens (mainly alfalfa leaflets). All of the crops contained vegetable material. Animal material, consisting almost entirely of insects (mainly beetles, true bugs, and ants), occurred in 68.4% of the crops, but volumetrically it accounted for only 1.6% of the total food content. Less than 500 individual insects were present, a mere trace compared with the more than 60,000 separate food items identified. This extreme preponderance of vegetable material has been previously reported for other parts of the species' range. Although at least 87 plant species were represented, 22 of these made up 90.4% of the total volume, and 92.8% of the total number of individual items. Plants of the legume, goosefoot, grass, and sunflower families were especially well represented in the diet. Marked use of native legumes such as mesquite (*Prosopis juliflora*), screwbean (*Prosopis pubescens*), and peabush (*Dalea scoparia*) was very noticeable. Equally so was heavy utilization of exotic weeds such as Russian thistle (*Salsola kali*) and Johnson grass (*Sorghum halepense*), as well as of exotic crop plants such as sorghum (*Sorghum vulgare*) and alfalfa (*Medicago sativa*). It is suggested that flexibility in feeding habits may help to explain the continued success of Gambel's quail in regions greatly altered by farming and grazing.

Gambel's quail (*Lophortyx gambelii* Gambel) is an important game bird in New Mexico. It is widely distributed over the lower elevations of the southwestern part of the state, and ranges up the Rio Grande Valley and drainage area at least to a point well north of Albuquerque. It also occurs eastward of this drainage in and around the Tularosa Basin. It occurs in the San Juan drainage area of northwestern New Mexico, and there are isolated pockets of apparently permanent introduced range elsewhere in the State. Aside from New Mexico, the various subspecies of *L. gambelii* occupy a rather large area in the States of Arizona, California, Colorado, Nevada, Texas and Utah, as well as the Republic of Mexico.

This paper deals with the food habits of Gambel's quail near the eastern periphery of its native range, and is further restricted to the fall season. The conclusions are based on the analysis of 57 crops, distributed as follows: October, 4 crops; November, 38 crops; December, 15 crops. The earliest collection date was October 12 and the latest was December 10. All collections were made during the year 1938–41. Col-

lections were made by A. E. Borell, Regional Biologist, U. S. Soil Conservation Service, and by several other federal employees. The crop analyses were made by John Weigel and Hewson Swift of the U. S. Fish and Wildlife Service. These crop analyses came into my possession by way of A. E. Borell, who received them from A. L. Nelson, Director of the Patuxent Research Refuge, Fish and Wildlife Service, Laurel, Maryland. Both Mr. Nelson and Mr. Borell have kindly consented to the present use of the data.

All 57 crops considered in this study were collected in the Rio Grande drainage area from the vicinity of Albuquerque on the north to that of Las Cruces on the south. On the basis of geography, all represent one subspecies of Gambel's quail. There appears to be some uncertainty as to whether this race should be called *L. g. gambelii* (see Peters, 1934; Ridgway and Friedmann, 1946) or *L. g. sanus* (see Aldrich and Duvall, 1955). The latest AOU Checklist (ed. 5, 1957) accepts the latter.

Over the years, several studies on Gambel's quail food habits have been published. For example, Gorsuch (1934) published the results of studies he made in southern Arizona, and Gullion (1954) reported on investigations in Nevada. In an early study, Judd (1905) reported on the contents of crops taken mainly in Arizona and Utah. All these habitats are quite different in many respects from the New Mexico areas occupied by Gambel's quail. Martin, Zim, and Nelson (1951) include a brief general account of the year-around diet of Gambel's quail. This is based on 441 crops taken in many parts of the range of the species. The 57 crops considered in the present paper were included in that summary (personal communication from A. L. Nelson). Apparently, however, no Gambel's quail food habits studies dealing specifically with New Mexico have previously been published, and for this reason it is believed that this paper may serve a useful purpose for the local region covered. Further studies to include all seasons of the year would obviously be very desirable.

Of the crops here reported, 57 (100%) contained seeds and/or fruits, and 33 (57.9%) contained greens. Animal material was present in 39 (68.4%) of the crops. This consisted almost entirely of insects. Grit was found in 23 (40.4%) of the crops. Four of the birds (7%) had eaten traces of feathers, probably from their own plumage. The crop of at least one bird contained appreciable amounts of debris from cattle droppings. This probably reflects the known quail habit of feeding in such droppings, evidently in search of undigested seeds. It is perhaps significant that this particular crop contained an unusual number of mesquite seeds.

The total measurable volume of food in this series of crops amounted to 178.9 cc., or an average of 3.1 cc. per crop. Of the total volume, 98.1% consisted of plant material. This was made up of 91.6% seeds and fruits (mainly seeds) and 6.5% greens (mostly alfalfa leaflets). Insects made up virtually all of the remainder of the crop contents (1.6%), while grit and debris made up the remaining 0.3%. These findings are in agreement with previously reported conclusions for other parts of the species range to the effect that Gambel's quail are highly vegetarian (Judd, 1905; Gorsuch, 1934; Martin, Zim, and Nelson, 1951).

Table 1 lists the first 22 foods in order of their volumetric occurrence in the total crop contents, and also indicates frequency of occurrence, number of separate items, and type of material. Volumetrically, these first 22 foods made up 90.4% of the total crop contents. The 59,204 separate items accounted for 92.8% of the countable grand total of 63,767. The importance of the noxious introduced weeds Russian thistle and Johnson grass in the diet is interesting. The former appears to be especially important. Quail are opportunists, and in areas where farming or overgrazing have tended to reduce their native foods and allow the invasion of exotics they have apparently altered their diet accordingly. This is also true of the partially associated scaled quail (*Callipepla squamata pallida* Brewster). Such versatility may help to explain the continued existence, and even abundance, of quail in many habitats which have been extensively altered by man and his domestic animals. Of the 22 food plants listed in Table 1, seven are exotics and 15 are natives.

The number of individual weed seeds consumed is certainly impressive, but probably no noticeable degree of control is exerted on introduced weeds even when quail are abundant. Neither are the birds' inroads on cultivated crops often of any economic importance, although an inspection of Table 1 indicates their fondness for domestic grains and alfalfa. The grain taken is nearly all waste gleaned from the soil, and quail are rarely if ever abundant enough to do any real damage to fields of alfalfa. Under certain special conditions of concentration, however, they sometimes damage truck crops enough in local areas to cause genuine concern.

The traditional importance of mesquite, screwbean and other native legumes in the diet of Gambel's quail is plainly shown in Table 1, but several other plant families are also well represented. The 22 food plants listed in Table 1 are distributed as to family in the following way: Leguminosae, 5; Compositae, 4; Gramineae, 4; Chenopodiaceae,

TABLE 1. *First 22 foods by volume.*

Technical Name	*Common Name*	*Part Used*	*Volume*		*Frequency*		*No. of Items*
			cc.	*% total*	*No. Crops*	*% Crops*	
Salsola kali	Russian thistle	Seeds	27.4	15.3	19	33.3	7,283
Prosopis juliflora	Mesquite	"	17.6	9.8	29	50.9	414 + Frgmts.
Verbesina spp.	Crownbeard	"	15.5	8.7	32	56.1	3,256
Brickellia sp.	Brickellbush	"	12.8	7.2	7	12.3	14,688
Sorghum halepense	Johnson grass	"	11.3	6.3	16	28.1	1,646
Sorghum vulgare	Sorghum	"	10.0	5.6	3	5.3	465
Dalea scoparia	Peabush	"	9.9	5.5	9	15.8	1,789
Medicago sativa	Alfalfa	Leaflets	8.8	4.9	14	24.6	Frgmts.
Hemizonia sp.	Tarweed	Seeds	7.5	4.2	1	1.8	10,000
Phaseolus vulgaris	Common bean	"	6.7	3.7	5	8.8	35
Prosopis odorata	Screwbean	"	6.3	3.5	21	36.8	993
Bassia hyssopifolia	Smother-weed	"	5.3	3.0	7	12.3	3,120
Zea mays	Corn	"	4.4	2.5	4	7.0	24
Helianthus sp.	Sunflower	"	2.9	1.6	8	14.0	394
Euphorbia sp.	Spurge	"	2.4	1.3	15	26.3	2,725
Boerhaavia sp.	Spiderling	"	2.3	1.3	13	22.8	1,346
Chenopodium sp.	Pigweed	"	2.1	1.2	20	35.1	3,991
Ibervillea tenuisecta	(None)	"	1.9	1.1	2	3.5	31
Sphaeralcea sp.	Globemallow	"	1.9	1.1	9	15.8	1,246
Trianthema portulacastrum	Pigweed	"	1.8	1.0	9	15.8	444
Chilopsis linearis	Desert willow	"	1.4	0.8	6	10.5	81
Eragrostis sp.	Love grass	"	1.4	0.8	13	22.8	5,233
Sub-totals			161.6	90.4			59,204
All other foods			17.3	9.6			4,563
Totals			178.9	100.0			63,767

3; plus one each for Aizoaceae, Bignoniaceae, Cucurbitaceae, Euphorbiaceae, Malvaceae, and Nyctaginaceae.

Besides the plants listed in Table 1, at least 65 other plant species occurred in this series of crops. All of these were present in very small or merely trace amounts, and most were represented in only a few crops. The main exceptions to the latter rule were *Amaranthus* sp. (17 crops), *Portulaca* spp. (16 crops), *Setaria* spp. and *Eriochloa* sp. (each in 11 crops). Altogether, these four genera made up only 1.3 cc. (0.7%) of the total food content.

A somewhat surprising omission from the diet, in view of the frequency in the habitat, and the favorable size and abundance of the seeds, are plants of the cactus family. Cactus seeds (*Opuntia leptocaulis* and *Opuntia* sp.) were present in only two crops. There were only six seeds, and these accounted for but 0.7 cc. This omission seems still more remarkable in view of the fact that scaled quail in partially overlapping range make considerable use of cactus (Martin, Zim, and Nelson, 1951; Campbell, 1957). Gullion (1954) also comments on the lack of cactus seeds in the diet of Gambel's quail in Nevada.

The 65 plant species occurring in the crops but not listed in Table 1 represented 27 families. Most of these comprised only one or two species, but the grasses accounted for 17 species (1.3 cc.) and the legumes for five (2.6 cc.). The Solanaceae and Compositae both accounted for four species, with a total volume of 0.6 cc. and a trace, respectively.

As previously stated, animal material occurred in 39 (68.4%) of this series of crops. Despite this rather high frequency of occurrence, which probably indicates a considerable degree of qualitative importance in the diet, the total volume of animal material was only 2.9 cc., or 1.6% of the total food content. The actual number of countable items (*i.e.*, minimum number of individual animals) was only 473, or a mere trace compared to the more than 60,000 separate items eaten. Virtually all of this meager quantity of animal material consisted of insects, a single exception being an unidentified spider. Insects of the following orders were present: Coleoptera, Hemiptera, Hymenoptera, Orthoptera, Mallophaga, and Lepidoptera. A few crops also contained small numbers of unidentified insect eggs.

Coleoptera were present in 23 crops. A total of 184 beetles were counted, and their volume totalled 0.7 cc. The following forms were recognized: *Diabrotica 12-punctata* and *Diabrotica* sp. (cucumber beetles); *Altica* sp. (chrysomelid beetle); and *Aphodius* sp. (small dung beetle). Undetermined species of the following families were

also present: Curculionidae and Mylabridae (weevils); Coccinellidae (ladybird beetles); Scarabaeidae (scarabaeid beetles); and Dermestidae (dermestid beetles). The last-named may have been a contamination. The ladybird beetles were by far the most numerous, there being at least 124 individuals.

Hemiptera were present in 15 crops. There were 258 of them, amounting to 2.2 cc. The following were identified: *Lygaeus lateralis* (chinch bug); and *Stictocephala* sp. (treehopper). Undetermined species of the following families were found: Cicadellidae and Jassidae (leafhoppers); Tingidae (lace bugs); Aphididae (aphids); Corizidae (corizid bugs); and Pentatomidae (stink bugs). The aphids were by far the most common, with at least 232 individuals and 1.7 cc.

Hymenoptera were found in 13 crops, and consisted almost entirely of ants. The only exception was a chalcid wasp in one crop. The following ants were identified: *Dorymyrmex pyramicus*, *Formica perpilosa*, *Formica* sp., and *Myrmecocystus* sp. Only 16 individuals were present, and their combined volume was too small to measure. There seems to be a common belief in New Mexico that ants are very poisonous to quail if eaten. In October, 1951, I examined a freshly dead scaled quail whose crop was literally crammed with large ants *(Camponotus vicinus)*. The bird was picked up in an area of northeastern New Mexico where quail were at that time reported to be mysteriously dying in large numbers. The actual cause of death of the bird I examined, unless due to ant poisoning, was not evident and could not be determined. Whatever the facts may be, ants of at least some species, and in small numbers, apparently are a normal part of the diet of Gambel's quail. This is also true of scaled quail (Martin, Zim, and Nelson, 1951; Campbell, 1957).

Other insect orders were very poorly represented in these crops. Grasshoppers were the only Orthoptera, and were present in only trace amounts in but three crops. There were a few Mallophaga (biting lice) in one crop, and a trace of lepidopterous larvae in one.

It appears that the insect diet of Gambel's quail, at least in the fall and in the area studied, is much too small to have any economic importance.

Summing up, four things appear outstanding, namely, (1) the extreme predominance of plant materials in the diet, (2) the special importance of legumes, chenopods, grasses, and composites, (3) the wide variety of plant species used to at least some degree, and (4) the versatility of the birds in heavily utilizing both wild and cultivated exotics now common in their environment.

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THE SOUTHWESTERN NATURALIST 2 (2–3): 129–133 APRIL-JULY, 1957

NOTES

SISYMBRIUM **Shinnersii** M. C. Johnston, NEW NAME.—Based on *Thelypodium Vaseyi* Coulter, Contrib. U.S. Nat. Herb. 1: 30, 1890; as emended by Payson, Univ. Wyo. Publ. Bot. 1: 16–17, 1922. TYPE: Rio Grande City, Starr Co., Texas, *Nealley 188 = 12*, in 1889 (US). *Sisymbrium Vaseyi* (Coulter) Payson, Univ. Wyo. Publ. Bot. 1: 15. 1922. Not *S. Vaseyi* S. Wats. ex B. L. Robinson in Gray, Syn. Fl. N.A. 1 (1): 138. 1895. The latter is an entirely different Mexican species. The Texan plants are spring annuals, apparently found only on clay loam in the Recent floodplain and delta of the Rio Grande, and rather rare. In addition to the Nealley specimen, I have seen *Runyon 3788* (US), from dry brush near Barreda, central Cameron Co., Texas. Payson also cites *Tracy 9197* (MO), from Olmito, Cameron Co., 15 April 1905.—*Marshall C. Johnston., 1118 East Polk St., Harlingen, Texas.*

SCARCITY OF WILD BEES AND WASPS (HYMENOPTERA ACULEATA) IN NORTH CENTRAL TEXAS IN 1957.—The year 1956 was one of the driest on record in northern Texas. Plant collecting was poor even in the ordinarily lush spring months. Populations of anthophilous bees and wasps were restricted by lack of forage, but it was still possible to collect them in fair numbers where flowers were available. The year 1957 was one of the wettest on record. While growth of some plants was depressed by the unusual number of cloudy or rainy days, there was a spectacular floral display during spring and most of the summer. Only August was a dry month. Rains resumed in September, and in mid October came a lesser repetition of the deluges of April, followed by sunny days and cool nights. Despite the abundance and excellent condition of flowers, there was the poorest collecting of bees and wasps in the ten years I have been giving attention to them. These contrary population fluctuations are biological facts of enormous ecological and evolutionary significance. They do not lend themselves to measurement, or even to reasonable quantitative estimates. In an age obsessed with statistics, it is almost a breach of propriety to report them. But I heartily agree with the opinion of Neil E. Stevens ("The excessive meekness of American botanists," Science n.s. 85: 580–582, 1937; reprinted in Chron. Bot. 11 (3): 159–161, 1948), that biological facts are more important than mere mathematics, and are not to be ignored when they cannot serve as vehicles for the latter. It is worth repeating Sarton's declaration, quoted by Stevens: "No scientist worth his salt has even abandoned an investigation simply because the attainable precision was too low."

Partly because of often unfavorable weather, partly because of pressure from other work, little collecting of Hymenoptera was attempted during 1957. But even with casual and incidental observation, the drop in populations was too pronounced not to be repeatedly noticed. At Dallas, the main period of activity of native bees and wasps is ordinarily from March through October. The greatest variety of bees occurs in April, May, and June, coinciding with the greatest variety of flowering plants. The greatest variety of wasps occurs from June to October, coinciding with the warmest months of the year. Rain and cold weather shortened the 1957 season at both ends. In the next paragraph are given some highlights of observations made on the S.M.U. campus and in waste ground between the Expressway and railroad, half a mile to the east; the area is one of calcareous clay soil, oiginally mostly

prairie. Following these are some stray notes from trips made elsewhere in sandy areas.

WASPS. Several species of *Polistes* (Vespoidea), at least two ordinarily rather abundant, were not seen during the spring, and were very scarce in summer and fall. *Rygchium* (Vespoidea), one of the more frequent of the smaller vespids, was not seen at all. In fall a number of Pompilidae (Vespoidea), were observed but not on flowers. BEES. *Andrena verecunda.* Normally a common spring species, oligotropic on *Pyrrhopappus Geiseri;* none seen this year. (The host flowers are open only from about 7 A.M. to 12 M. except in cloudy weather and toward the end of their blooming season. What the bee does the rest of the time is a mystery. It has never been found on anything else.)—*Halictus ligatus.* Normally a common species with a very long season (spring to fall), visiting a great variety of flowers. None seen this spring, few in summer and fall.—*Lasioglossum.* A small black species nests in the lawn about the S.M.U. Science Building, has a long season like the preceding (generally most abundant in early summer), and visits a variety of flowers. (Its early-summer favorite, and in dry years almost its only available plant, is the introduced possession weed, *Convolvulus arvensis,* whose flowers are open only in the morning, like those of *Pyrrhopappus Geiseri.* The bee is evidently able to adapt itself not only to an exotic plant, but to a truncated activity-period.) None seen this spring. A different and regularly less common species was seen in July.—*Dianthidium sayi.* Present in summer and fall, almost exclusively on annual sunflower, *Helianthus annuus;* never really common. Collected in August; by comparison with nearly all other bees, there was no great change in abundance.—*Osmia* (and/or *Diceratosmia;* indistinguishable in the field). Normally fairly common in early summer, especially on thistles *(Cirsium).* None seen this year.—*Megachile.* A number of species, most of them common from late spring to fall, and most visiting a variety of flowers. None seen this year until June 1 (one large female, on the introduced mimosa, *Albizia Julibrissin*). The introduced *M. rotundata* was collected August 1 on *Phyla incisa;* abundance about average. Few species seen all season, and these (except *rotundata*) very scarce.—*Diadasia enavata.* Normally one of our most plentiful native bees from early summer to fall, almost exclusively on *Helianthus annuus.* None seen this year.—*Melissodes.* Two fairly common species, with same season and host plant as *Diadasia enavata.* The large species (perhaps *M. obliqua*) was rare, the other not seen.—*Ceratina.* Small black bees superficially resembling *Lasioglossum,* with about the same season and host plants, but never as abundant. Present this year but considerably less common than usual.—*Xylocopa micans, X. virginica* (incl. *texana*). Both rather common in spring and early summer; none seen this year.—*Bombus americanorum.* Usually common from spring to fall. None seen this spring, few in summer and fall.—*Apis mellifera.* The introduced honeybee was active all year, as usual, but much less plentiful than usual at all seasons.

In sandy areas, bee populations were less reduced than at Dallas. Species of *Perdita* (almost never found in areas of clay soil) were nearly as plentiful as usual (collected in August in Montague Co., Texas, and Cotton Co., Oklahoma, on *Prionopsis ciliata;* also in July south of our area in Austin Co., Texas, on *Helianthus cucumerifolius*). Also in August in Montague Co. *Agapostemon, Halictus ligatus, Diadasia enavata,* and *Bombus* were collected on *Helianthus annuus; Agapostemon, Lasioglossum, Nomada,* and *Bombus* on *Lythrum lanceolatum* (the plant is here at its western limits). The only good collecting for the year was in sandy areas west of the longitude of Dallas.

The exact explanation of the reduced insect populations is a matter of conjecture.

Some were ground-nesters (e.g. *Andrena*, *Lasioglossum*, *Bombus*), others were not (e.g. *Polistes*, *Rygchium*, *Xylocopa*, *Apis*). Presumably humidity and temperature as well as presence of excess water played a part. Whether the influences were direct on physiological activity, or indirect through increase of destructive organisms (parasites, fungi, etc.), or caused physical damage or destruction, is not known. Some of the insects are social, with a worker caste and over-wintering queens *(Polistes, Bombus, Apis)*, *Xylocopa* is gregarious, with overwintering adults; most are solitary. passing the dormant period as pupae. Differences in survival were not correlated with these differences in life-habits.

Most striking is the complete contrast between the reaction of the flowering plants and that of their pollinators to the abnormal weather conditions. If the excessively popular theories about the intimate evolutionary association between the two groups of organisms were correct, there should not be such completely opposite behavior. Alleged adaptations of particular insects to particular flowers are based on only a fraction of the total picture. An enormous amount of data about phenology, life histories, and geography must be accumulated before it is safe to begin theorizing about adaptations. The response of the Hymenoptera does accord with the general idea that the higher groups (which are the ones chiefly involved in pollination) derive from desert or semi-desert regions. Among bees, there are few distinctly northern genera (e.g. *Colletes*, *Andrena*, *Bombus*). In Texas certainly the predominance of southern types is overwhelming, but only in the southwestern part of the state is there a similar (and it is less extreme) condition in the flora. In terms of geography, there is the same contrast between the bee fauna and a major portion of the flora as appeared in their responses to the wet weather of 1957. It is possible that the influence of weather, coupled with topography and soils, may explain the spotty occurrence of populations of most of our wild bees. Certain species can be found almost everywhere; others are unpredictable: one may find them in abundance in one colony of an apparently favorite food plant, but search in vain for them in other stands of the same plant. It may be conjectured that exceptional weather wiped out all populations but those in certain suitable spots. Unfortunately we know extremely little about the life histories of our wild bees, and almost nothing about their cruising range and capacity to colonize new areas.—*Lloyd H. Shinners, Southern Methodist University, Dallas 5, Texas.*

ANTHOPHOROID BEHAVIOR OF A HONEYBEE, APIS MELLIFERA (HYMENOPTERA-APOIDEA).—The habit of hovering fixed in one spot, then darting to another, is found in a number of unrelated anthophilous animals, such as hummingbirds, hawk-moths, many flies, and certain bembicine wasps. Among bees, it is especially noticeable in species of *Anthophora* and *Hemisia*, moderately to rather large and chunky insects, but capable of swift flight. By contrast with these, and with such speed-demons as *Agapostemon*, *Megachile*, and *Melissodes*, the familiar honeybee is a rather steady and slow-paced worker. An introduction from the Old World, it is now one of our most abundant bees, and a rare instance of a naturalized introduction which is wholly beneficial. Despite its abundance, it shows remarkably little variation in behavior. An instance of some thing strikingly different (unique in 10 years of collecting pollinating insects) is worth recording. On July 20, 1957, a bee was seen behaving like an *Anthophora* or *Hemisia* around flowers of trumpet creeper, *Campsis radicans*, along a sandy roadside 1.6 miles west of Marlin, Falls Co., Texas. Since excessive rains had made this an extremely poor year for bee-collecting, and since the locality was farther east than I had seen members of the two bee genera, plant-pressing was halted temporarily in order to capture the

insect. The first step was to try to see it actually visit the flowers, which it did not do for some minutes. It hovered quite close to them, fixed rigidly in one spot, then shifting abruptly to hover in another, moving erratically about, sometimes behind leaves, sometimes moving from one blossom to another. It landed briefly, working the large anthers. (It is worth interjecting that the broadly tubular corollas of *Campsis* are not at all the type usually considered to be adapted to bees, or vice versa; nevertheless they are regularly visited even by diminutive *Lasioglossum*, and by ants.) That it had done so before was evident from the heavy loads of whitish pollen in its leg-baskets. So consistently and distinctively *Anthophora*-like or *Hemisia*-like was its behavior that not until after capture did I realize it was only a honeybee. In Michener's classification (Comparative External Morphology, Phylogeny, and a Classification of the Bees (Hymenoptera), Bull. Amer. Mus. Nat. Hist. 82 Art. 6), the two genera mentioned as displaying hover-type behavior are included in the family Apidae, though previously they had generally been segregated in the Anthophoridae. That the honeybee may also hover and dart, if only exceptionally, is a minor bit of evidence to support the merger. The orthodox and immediate explanation of the peculiar behavior I observed is atavism, based on the supposition that the highly socialized honeybee represents an advanced type in other aspects along with the social habit, and derives from more primitive anthophorid stock. Being an unconventionally cautious phylogenist, I do not regard this as a safe inference. There may have been only a spontaneous mutation of the kind which produces the well-known homologous variations among related kinds of plants (see N. I. Vavilov's The Origin, Variation, Immunity and Breeding of Cultivated Plants, translated by K. Starr Chester, Chron. Bot. 13 (1/6), 1949/1950). It merely tells us once more what we already know: that the genera *Apis*, *Anthophora*, and *Hemisia* have many resemblances and presumably are fairly closely related. It proves nothing about their phylogeny or relative age. The adaptive value of hovering may be claimed because of the occurrence of similar behavior in other groups of insects and in birds which depend on flowers. But since the occurrence is so sporadic, and is not consistent within groups which show it, "adaptive pressure" can scarcely be given much credit for it. It simply represents one of a limited number of possibilities which are open to two- or four-winged animals, which have no decisive survival-value, and which may be realized through random mutations.—*Lloyd H. Shinners, Southern Methodist University, Dallas 5, Texas.*

NOTES ON THE GLOSSY SNAKE, ARIZONA ELEGANS, IN TEXAS.—Four adults and two juveniles of *Arizona e. elegans* were collected by the author at various localities in Robertson County, Texas, during the months of May and June, 1957. All but one were found DOR in deep sand hills. One was collected crawling out of a rodent burrow in deep sandy soil. These records extend the known range of this snake some 120 miles to the east from Comal County.

These localities are well within the Carrizo Sands formation. According to McBryde (Ecol. Monogr., 1933, 3(2):247–297), the Carrizo Sands extend from Carrizo Springs on the Rio Grande northeastward through Atascosa, Bexar, Comal, and Robertson counties, and northeastward into Bowie County of extreme northeastern Texas. Most of the Texas specimens of this subspecies examined by Klauber (Trans. San Diego Soc. Nat. Hist., 1946, 10(17):311–398), came from the first three counties. The dominant vegetation of the Carrizo Sands is oak-hickory and is nearly uniform throughout the formation. The soil consists of fine to loosely course sand from one to several feet in depth.

Klaubers's *(op. cit.)* locality and life history notes for this subspecies indicates that

the animals are common in sandy hills that are covered with oak and hickory near Somerset, Bexar County. This type of habitat is also present at the Robertson County localities. There are gradient differences in the amount of humidity and rainfall from southwest to northeast, but these differences are not pronounced and the dominant vegetation is not affected. It appears that *Arizona* has followed these sands toward the east and possibly its range extends farther to the northeast than Robertson County.

The individuals from Robertson County (East Texas), and Kleberg, Kenedy, and Brooks counties (South Texas) appear to represent the opposite ends of a cline with the specimens from Atascosa, Bexar, and Comal counties representing the intermediate sample. The East Texas animals have 29 midbody scale rows, 41–53 body blotches, those of the intermediate sample, equally divided 29–31 scale rows at mid-body, body blotches 42–56; the mid-body scale rows of the South Texas sample are uniform at 31, body blotches 44–54. The number of ventrals and body blotches follows the same trend. The number of ventrals is high in the east and progressively lower toward the west and south. The width of the body blotches is wide in the east and narrow toward the southwest. There is a definite cline in the color of the three samples. The eastern individuals are the darkest of any *Arizona* that I have seen. Specimens from South Texas are much paler than the eastern sample; the animals from the San Antonio region are intermediate in color.

An adult female from Fort Davis, Jeff Davis County, appears to represent an intergrade between *elegans* and *expolita* or *philipi* or both. The ratio of the tail length to over-all length is 12.8%, which agrees with that of the only known female of the subspecies *expolita*. The number of ventrals (211), caudals (46), and the width of the light interspaces (1–2 scales), indicate a relationship with both *expolita* and *philipi*. The number of mid-body scale rows is 31, which number is normally found in *elegans*, while the number of body blotches (58) is well within the range of *philipi*. It is apparent that this individual is not a true *elegans* and the animal's relationship with the subspecies *expolita* and *philipi* indicates that the Davis Mountain region may be an area of intergradation between three subspecies of *elegans*.

An adult male from Canadian, Hemphill County, appears to be an intergrade between the subspecies *elegans* and *blanchardi*. The mid-body scale rows, ventrals, caudals, body blotches, and tail-total length ratio (respectively 29, 212, 57, 49, and 15.4%) fall within the range of variation of both subspecies. However, the number of body blotches and ventrals is closer to the average of *elegans* while the ratio of the tail to the total length approximates the average of *blanchardi*. This specimen comes from a locality well within the range of *blanchardi* as designated by Klauber *(op. cit.).—James R. Dixon, Department of Wildlife Management, Agricultural and Mechanical College of Texas, College Station, Texas.*

INFORMATION FOR CONTRIBUTORS

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CONTENTS

Botany

Phoradendron serotinum for *P. flavescens* (Loranthaceae): nomenclatural corrections. *Marshall C. Johnston* . . 45

Salt cedars (*Tamarix*, Tamaricaceae) of the Soviet Union, by S. G. Gorschkova: translation and commentary. *Lloyd H. Shinners* 48

Zoology

Anatomy and life cycle of the snail, *Rumina decollata* (Pulmonata: Achatinidae). *Jeanne Hines Batts* . . 74

Tejachernes (Arachnida-Chelonethida, Chernetidae-Chernetinae), a new genus of pseuroscorpion based on *Dinocheirus stercoreus. C. Clayton Hoff* 83

Distribution patterns of Texas fresh-water fishes. *Clark Hubbs* 89

Observation on the natural history of four species of whiptail lizard, *Cnemidophorus* (Sauria: Teiidae) in Trans-Pecos Texas. *Wm. W. Milstead* 105

Fall foods of Gambel's quail (*Lophortyx gambelii*) in New Mexico. *Howard Campbell* 122

Notes

Sisymbrium Shinnersii M. C. Johnston, new name. *Marshall C. Johnston* 129

Scarcity of wild bees and wasps (Hymenoptera Aculeata) in north central Texas in 1957. *Lloyd H. Shinners* . . 129

Anthophoroid behavior of a honeybee, *Apis mellifera* (Hymenoptera-Apoidea). *Lloyd H. Shinners* . . . 131

Notes on the glossy snake, *Arizona elegans*, in Texas. *James R. Dixon* 132